# CIVILIZATION

OF

# THE EASTERN IRANIANS

## IN ANCIENT TIMES.

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# CIVILIZATION

OF

# THE EASTERN IRĀNIANS

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WITH

*AN INTRODUCTION ON THE AVESTA RELIGION*

BY

DR. WILHELM GEIGER

AUTHOR OF 'A MANUAL OF THE AVESTA LANGUAGE,' 'AOGEMADAÊCHÂ,' ETC.

**Translated from the German**

WITH A PREFACE, NOTES, AND A BIOGRAPHY OF THE AUTHOR

BY

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MEMBER OF THE GERMAN ORIENTAL SOCIETY, AND OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY, SIR JAMSHEDJEE FELLOW (AVESTA AND PAHLAVI) OF THE SIR JAMSHEDJEE JIJIBHAI ZARTHOSHTI MADRESSA

VOL. I.—ETHNOGRAPHY AND SOCIAL LIFE

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1885

TO THE MEMORY OF

THE LATE

**SIR KĀVASJEE JEHĀNGIR READYMONEY, KT., C S.I.**

THIS TRANSLATION OF

DR. WM. GEIGER'S

*CIVILIZATION OF THE EASTERN IRANIANS*

IS MOST RESPECTFULLY INSCRIBED

BY HIS AERPAT

DĀRĀB DASTUR PESHOTAN SANJĀNĀ.

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# TRANSLATOR'S PREFACE.

THIS History of the Civilization of the Eastern Irānians in ancient times is a translation of a German work, *Ostīrānische Kultur im Alterthum*, by Dr. Wilhelm Geiger, of Neustadt, a diligent investigator and judicious writer, whose extensive and detailed researches into the history and religion of the primitive Zoroastrians have become the subject of intense curiosity and interest among Oriental scholars in Europe. A pupil of Dr. Friedrich von Spiegel for more than nine years, Dr. Geiger seems to have succeeded, at least partially, by his unsparing efforts, in bringing Science and Tradition into mutual harmony and co-operation. And the following pages embody the most comprehensive results of his searching and indefatigable labours, during the last decade, towards ascertaining, from the genuine but scanty references in the Avesta[1] as now extant, the moral, social, economical, religious and (to a certain extent) political conditions of the early inhabitants of Eastern Irān, the first spontaneous adherents of the faith revealed by the philosophic poet, priest and prophet, SPITAMA ZARATHUSHTRA.

By those who, being familiar with German, are devoted to Irānian studies, the original work, which is unique in

[1] 'Within this awful volume lies
The mystery of mysteries.
Oh! happiest they of human race,
To whom our God has given grace,
To hear, to read, to watch, to pray,
To lift the latch and force the way;
But better had they ne'er been born,
Who read to doubt, or read to scorn.'—B.

Avesta literature and is composed after the plan of Dr. Zimmer's *Altindisches Leben*, is already known and appreciated; and the favourable attention paid to it by European scholars is a sufficient guarantee of the great value of its contents. It is needless here to point out what fresh seeds have been sown and what useful fruits are in store for the votaries of Eastern culture; however, it may be interesting to recount in brief the services which our young author has rendered to students of the Avesta by his close and careful investigations.

He has shown us that among the civilized nations of the early East, the history of the Avesta nation[1], apart from its ethnological importance, lucidly illustrates the fact, so long questioned, that several of the germs of what is best in Western civilization are to be detected in the doctrines and institutions of Irānian antiquity. It should not be supposed that I mean to assume any extensive borrowing on the part of Western nations; my main object has been to express my conviction that the mighty Genius, Zarathushtra Trismegistos, who succeeded in promulgating the Mazdayasnian Faith throughout the East, was without question one of the most ancient promulgators of those ideas which have contributed and will contribute for ever to the moral and material welfare of millions of God's creatures.

The author's picture of private life in the early Irānian home is of the greatest value and interest. In the honoured position assigned to the *Nmānō-pathni* 'the lady of the household' by the *Mazdayasnān* we may recognise the original of European chivalry; while in the political assemblage[2] of the *Nmānō-paiti* 'pater-familias,' *Vis-paiti* 'lord of a village,' *Zantu-paiti* 'president of a community or lord of a county,' and *Daghu-paiti* 'prince or ruler of a country,' with the *Zarathushtrotema* 'the spiritual and temporal sovereign' at their head, we may equally trace the germs

[1] The early Irānian people as represented in the Avesta.

[2] *Hanjamana.*

of the constitution of a modern monarchical kingdom in Europe.

Dr. Geiger's exposition of the Avesta doctrine of the Soul reveals a fresh point of historical interest. It clearly proves that the Avesta nation had already attained the utmost degree of knowledge regarding the Spirit which men have ever reached, and beyond which it has been found impossible for them to proceed, after millenniums of labour, unless some new method of acquiring spiritual knowledge can be discovered.

Furthermore, we see from the section on 'Morality' that the mission of Zarathushtra was of the highest moral significance. The Avesta lore does not merely enrich the world in respect to spiritual thoughts and religious tenets, but its principal aim is purely ethical, to inculcate upon mankind that '*Righteousness is the best virtue for man from his very birth!*'

A far more interesting mode of usefulness assigned by the author to the Avesta consists in the fact, that, but for its preservation and scientific elucidation, we should hardly have had any information regarding the Eastern regions of Irān; that we should never have been cognisant of the extremely important fact that Eastern Irān was not merely the most primitive home of the Zarathushtrians but also the birthplace of their civilization; nay more, that Irān was 'the true national centre, whose importance in the general sum of the national history was decidedly superior to that of the West.'

Such are the ideas which naturally strike us while we survey the field of our author's research. However, it must be borne in mind that its extent cannot compare with the wide area over which Doctors E. W. West and Fr. von Spiegel have spent their lives in search of truths hidden beneath the dense forest of Eastern science. What these *pandits* of Pahlavi and Avesta research have achieved, is well known among those to whom their works serve for

daily reference; but I cannot here omit to mention that in the absence of any memorial on the part of the modern Parsi Community to perpetuate their literary services, their elaborate works will ever remain as monuments marking an important epoch in the history of Irānian literature.

With these preliminary remarks, I beg to submit a few observations as regards the translation:—

In this book, which is intended to meet the wants of the general English-reading public, and more particularly of the literary portion of the Zoroastrian Community, my purpose has been to render into clear and simple English, as far as practicable, such of the chapters as are, in the opinion of the author and the translator, of general interest. Thus the Chapter and Section that are named the first, are the third and twenty-third respectively in the German original. The version of passages from the Avesta and the Veda is strictly literal; while in the body of the work a free rendering has been given wherever a literal translation would have made the language rather uncouth and inelegant. Italics are used for Avesta words, verses, sentences, or paragraphs, sometimes for Vedic and Pahlavi, sometimes for meanings of Avesta words and proper names, and usually for those words that are intended to be emphasized. The transliteration of the Avesta alphabet adopted for this volume is given on page xxi. All notes, expressions of agreement with or dissent from the views of the author, and quotations written by me are enclosed in brackets [ ] to distinguish them from the original notes by the author. It is also to be observed that the translator does not hold himself responsible for all the views put forth by the German writer as regards his interpretation of the Avesta religion.—In the translation a few italicized words are inserted in brackets, thereby suggesting any other view believed to be more certain or probable. In order not to perplex my Parsi readers, it has often been considered proper not to translate the

Avesta proper names but only to adopt their transliteration; e.g. *Mazdayasna* for Mazda-worshipper, *yazata* for genii, &c. It is to be remembered that other works of the author as well as of other German scholars are quoted in italics under their original German titles or abbreviations.

The Introduction, containing a brief though impartial and scientific exposition of the Avesta religion, was written in German, at my request, by the author, who has also kindly perused my manuscript before it went to the press and expressed his opinion thereon. He has, likewise, given his consent to several alterations, additions, or omissions as compared with the original. To him my special and heart-felt thanks are due.

I must take this opportunity of acknowledging my deepest gratitude to my German teacher, Mr. G. Reifferscheid, of Messrs. B. and A. Hormaryee, for his kind and voluntary instruction, as well as for the prompt assistance he has rendered me in the course of my work.

I must not also conclude this Preface without tendering my warmest thanks to Dr. Alois Fuhrer and Mr. Principal Wordsworth for the kind manner in which they consented to compare my translation with the German original, and gave their opinions regarding it.

DĀRĀB DASTUR PESHOTAN SANJĀNĀ.

BOMBAY, *January* 1, 1885.

# BIOGRAPHICAL SKETCH.

Dr. Wilhelm Geiger, son of an evangelical clergyman, was born at Nürnberg, Bavaria, on the 21st of July 1856. In 1861 he entered the Gymnasium of his native town, where he completed his primary education by the end of 1873. At the age of 17 he became a member of the University of Erlangen, where, during several sessions, he attended the lectures and other instructions of the famous Professor Friedrich von Spiegel, with whom he had the good fortune to form a close acquaintance and to whom he was deeply indebted for his ingenious and delightful initiation into Sanskrit, Avesta, Pahlavi and Persian studies. He next visited the Universities of Bonn and Berlin, where nothing possessed such attractions for him as the Avesta literature. 'The antiquity of the Avesta,' says Dr. Geiger in one of his letters, 'its language and contents, the purity and sublimity of its religious and moral ideas, excited in me the greatest love and interest for Irānian research.'

By his first edition and translation of the 'Pahlavi version of the Vendidād, Chapter I.' (*Die Pehleviversion des ersten Capitels des Vendidād herausgegeben, nebst dem Versuch einer ersten Uebersetzung und Erklärung*, Erlangen, 1877), he obtained the degree of Doctor of Philology in 1877, and was appointed in the same year *Privatdocent* (lecturer) of Oriental languages in the University of Erlangen.

In the year 1878 he published the Pazend, Old-Bactrian and Sanskrit Texts of 'Aogemadaēchā' (*Aogemadaēchā: ein Parsentractat in Pāzend, Altbaktrisch und Sanskrit, herausgegeben, übersetzt, erklärt und mit Glossar versehen;* Erlangen, 1878), of which, says the author, 'I found two MSS.

in the valuable collection of Dr. Martin Haug, while for the third one I am indebted to the kindness of the late Professor N. L. Westergaard of Copenhagen.'

Passing over his numerous essays published in the 'Journal of the German Oriental Society' (*Zeitschrift der deutschen morgenlandischen Gesellschaft*) &c., I may mention as his next publication his complete German 'Manual of the Avesta Language, containing a grammar, selections for reading, and glossary' (*Handbuch der Avestasprache, Grammatik, Chrestomathie und Glossar;* Erlangen, 1879), in which the author has judiciously given the words corresponding to every Avesta word, in the traditional translation, to show their importance and accuracy.

In the 'Journal of the German Oriental Society' (Vol XXXIV. pp. 415-427, Leipzig, 1880) he next published his translation of the Third Fargard of the Pahlavi-Vendidād. Since the autumn of the year 1881 he has resided in Neustadt as a professor in the Gymnasium.

From 1880 to 1882 Dr. Geiger was chiefly engaged in elaborating his comprehensive history of the 'Civilization of the Eastern Irānians' (*Ostīrānische Kultur im Alterthum, mit einer Uebersichts-Karte von Ostīrān*; Erlangen, published by Andreas Deichert, 1882), of which a translation, beginning with Chapter III. p. 167, has been given in this volume.

In the 'Transactions of the Royal Bavarian Academy' our author published last year his excellent Essay 'On the Father-land and Age of the Avesta and its Civilization' (*Ueber Vaterland und Zeitalter des Avesta und seiner Kultur*, 1884), in which he goes on to prove, courteously refuting the ideas or arguments of his predecessors, that the civilization of the Avesta people points only to Eastern Irān and belongs to a period long before the existence of the Median and Persian monarchies. He likewise puts forward several ingenious arguments in support of the view that Eastern Irān was the birth-place of the state of civilization

represented in the Avesta, and sums up his theory as regards the age of the Avesta in the following words:

'We begin with a *documentum e silentio*: The Avesta must have been in existence in a pre-Achaemenian, most probably in a pre-Median epoch. For (1) *no mention is made in the Avesta of cities famous during the Median period, with the exception of Ragha*, the high antiquity of which is thereby proved. (2) *The Avesta speaks of none of those tribes or nations that were commonly known at a later period.* Neither does it allude to the Persians, nor to the Parthians, nor to the Medes, but merely to the Arians. (3) *The Avesta contains no historical statement* concerning the battles between the Medes and the Babylonians, the rise of the Persians, the prosperity and downfall of the Persian Empire under the Achaemenian Dynasty, the invasion of Alexander the Great which agitated and reorganized the whole of the Orient, the kingdoms originating from the decay of the Empire of Alexander, the dominion of the Arsacidae.'

D. D. P. S.

# ABBREVIATIONS.

Afr. for Āfringān, ed. Westergaard; *AG* for *Alte Geographie* ('Ancient Geography'); *AiL* for *Altindisches Leben* ('Old Indian Life'); Av. for Avesta; *Av tr* for *Avesta, Livre Sacré du Zoroastrisme, traduit du Texte Zend* ('The Avesta, the Zoroastrian Scriptures, translated from the Zend Texts'), *Av. ub.* for *Avesta, die heiligen Schriften der Parsen aus dem Grundtexte übersetzt* ('The Avesta, the Sacred Writings of the Parsis, translated from the original Texts'); *Bdh.* for *Bundehesh* (Dr. West, 'Pahlavi Texts,' part I); Bh. for Behistun Inscriptions; bk. for book; B.R. for Bohtlingk and Roth, *Sanskrit Worterbuch* ('Sanskrit Dictionary'), ch. for chapter; *Comm.* for *Commentar uber das Avesta* ('Commentary on the Avesta'), Cf. or comp. for compare; *E.A.* for *Erānische Alterthumskunde* ('Eranian Antiquities'); ed. for edition, *Einl* for *Einleitung zur Uebersetzung des Rig-veda* ('Introduction to the Translation of the Rig-veda'); Essays. for Essays on the Sacred Language, Writings, and Religion of the Parsis, by M. Haug, 2nd edition by Dr. West; Essays (Yule). for Essays on the Geography and History of the Regions on the Upper Waters of the Oxus, in Wood's *Journey to the Source of the River Oxus*; *Expéd. scient.* for *Expédition scientifique Française en Russie, en Sibérie et dans le Turkestān*; *Gāthās* (Haug). for *Die fünf Gāthās* ('The Five Gāthās'); *GdA.* for *Geschichte des Alterthums* ('History of Antiquity'); *H.a.G.* for *Handbuch der alten Geographie* ('Manual of Ancient Geography'); *Hdb.* (Geiger) for *Handbuch der Avestasprache, Grammatik, Chrestomathie und Glossar* ('Manual of the Avesta Language, Grammar, Chrestomathy, and Glossary'); *Hdb.* (Justi) for *Handbuch der Zendsprache* ('Manual of the Zend Language'); Herod. for Herodotus; *I. A.* for *Indische Alterthumskunde* ('Indian Antiquities'); *Journey* for *Journey to the Source of the River Oxus*; *K. Z.* for *Kuhn's Zeitschrift* ('Kuhn's Journal'); Lev. for Leviticus; Lex. for Lexicon; Mkh. for Minokhired, ed. Dr. West; Mod. P. for Modern Persian; n. for foot-note; *Nationalokonomik* for *Nationalokonomik des Ackerbaus* ('National Economy of Agriculture'); N.P. for New Persian; Od. for Odyssey; O. Ir. for Old Irānian; *OKA.* for *Ostirānische Kultur im Alterthum* ('Civilization of the Eastern Irānians in Ancient Times'); O.P. for

Old Persian; p. for page; Pers. for Persian; Phlv. for Pahlavi; *P.M.* for *Petermanns Mittheilungen* ('Petermann's Contributions'); *Reise* (Shaw) for *Reise nach der Tartarei, Yārkand und Kāshghar* ('Visits to Tartary, Yārkand and Kāshghar'); *Reise* (Vambery) for *Reise in Mittelasien* ('Travels in Central Asia'); *Ride* for *Ride from Samarcant to Herāt*, by Ch. Marvin; rt. for root; *Russ. Rev.* for *Russische Revue* ('Russian Review'); Rv. for Rig-veda; seq. for sequentia; Sir. for Sirozah, ed. Westergaard; Skt. for Sanskrit; s. v. for sub voce; Tr. for Translator; Trad. for Tradition; *Trad. Lit.* for *Traditionelle Literatur der Parsen* ('Traditional Literature of the Parsis'); Vd. or Vend., Vsp., Ys. and Yt. for Vendidād, Visparad, Yasna and Yasht, ed. Westergaard; vol. for volume; *Voyages.* for *Voyages en Perse, dans l'Afghanistān, le Béloutchistān et le Turkistān*; *Wtb.* for *Worterbuch* ('Dictionary'); *Z.St.* for *Zoroastrische Studien* ('Zoroastrian Studies'); *Zddmg.* for *Zeitschrift der deutschen morgenländischen Gesellschaft* ('Journal of the German Oriental Society'); *ZdGfE.* for *Zeitschrift der Gesellschaft für Erdkunde* ('Journal of the Geographical Society').

# TRANSLITERATION OF THE AVESTA ALPHABET ADOPTED FOR THIS VOLUME.

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GUTTURALS.— a, ā, k, kh, q, g, gh, h.

PALATALS.— i, ae, ( ē), î, āí, ch, j, ( e, ē).

DENTALS.— t, *t*, th, d, dh.

LABIALS.— u, ao, ū, āu, ( ō,) p, f, b.

SEMIVOWELS.— or y, r, or v, w.

SIBILANTS.— s, *sh*, sh, z, zh.

NASALS.— m, n, or g̃, ā̃, ñ.

# INTRODUCTION.

In my history of the Civilization of the Eastern Irānians in Ancient Times I have characterized their religion in a few pages, since it would have been impossible for me to devote to that subject an equally detailed description of other features in their civilized life, without enlarging too much the extent of my book. But it may not appear superfluous to preface the English translation of some interesting chapters on Ethnography and Private Life (*Ostīrānische Kultur*, pp. 167–422) with an exposition of the Avesta religion—a subject of special importance to my readers amongst the Parsees—adhering to the principles which have guided me in the elaboration of the entire work. I shall endeavour also to describe the religion as plainly and vividly as possible, not merely according to its contents (*doctrines*), but also according to its spirit, its tendency, and its history. I shall further confine myself as closely as possible to the statements of the Avesta, abstaining from all allusion to later authorities as far as practicable.

## GENERAL REMARKS.

With the single exception of the Israelites, no nation of antiquity in the East has been able to attain to such purity and sublimity of religious thought as the Avesta nation. Nowhere do we meet with conceptions which approximate so closely to a pure monotheism, nowhere is the notion of the Deity so free from human adjuncts, nowhere is the purely spiritual part of religion worked out with such exactness and preciseness. If this in itself is sufficient to awaken universal interest, it must undoubtedly do so far more powerfully when we learn that this religion is not the result of a long unconscious development, but, on the contrary,

rather the outcome of conscious speculation. The Avesta religion was founded in Eastern Irān, and its institution is connected with the name of Zarathushtra Zarathushtra himself must have brought it already to perfection, as the legends of the Parsees indicate, on the soil of Media, whence he must have diffused it through the eastern provinces. Every founder of religion works with the aid of materials acquired from history. The Christian doctrine rests upon the basis of the old Judaic religion, Mahomet attempts to unite both Christianity and Judaism, while Zarathushtra grounds his work upon the old Arian religion of nature, which the Irānian nation shared with the Indian people.

Upon this fact of a common foundation are based all analogies between the Zoroastrian and the Brahmanical religions. It is not my task to enter here upon a discussion of their resemblances; I only remark that, according to my conviction, their similarity has been frequently exaggerated.

It is certain that Zarathushtra, conscious of its tendency, radically altered the existing materials. The form and tenor of the old religion were altered alike, to such an extent indeed, that scarcely anything has survived from the ancient faith except some names and certain primitive ideas. The last remnants of the symbolical conceptions of nature have been, scantily enough, preserved in certain *yazatas*[1], like *Mithra*, *Srausha*, *Anāhita*. But the characteristic and essential portion of the religion, that part in fact which gives it its true nature, is entirely a new creation.

In the place of the vague and irregular nature-worship, there appears a solid, compact, consistent system. The tenor of the new doctrine was essentially moral. The ethical conception of the Deity appears in the foreground, while the natural is withdrawn from view. In the earlier religion one deity stood on the same level as another.

[1] [Angels or spiritual Genii presiding over elements or elementary excellences as well as over physical, abstract, and ethical ideas. In the abstract, anything that is excellent and worthy of praise in the moral and material nature of the Universe and that glorifies the wisdom of the Deity is a *yazata*. *Translator's note.*]

Each was in his sphere the most influential; even more, according to the requirements of the moment each could be esteemed as the highest and the most powerful of all. This idea found no place in the new doctrine. The multitude of forces and powers was concentrated in a single deity, who stands far above all other supernatural beings—into

## I. AHURA MAZDA.

AHURA MAZDA is the Ruler and King of the invisible, as well as of the visible world. It is He Himself Who has revealed His holy religion to Zarathushtra. In His being Ahura Mazda is a spirit. His most conspicuous attributes are *Asha*, 'Holiness,' and *Chisti*, 'Wisdom.' Even His name describes Him as the 'Wise' (*Mazda*), and as the 'Lord' (*Ahura*)[1]. Extremely characteristic is the very address which constantly recurs in the Vendidad:

*Ahura · Mazda · mainyô · spēnishta · dātare · gaęthanãm · astavaitinãm · ashãum !*

'Ahura Mazda the Most Blissful Spirit, Creator of the Corporeal World, Thou Holy!'

Or more briefly only:

*Dātare · gaçthanãm · astavaitinãm · ashãum !*

'Creator of the Corporeal World, Thou Holy!'

With this we may also further compare the first words of the Yasna:

*Nivaedhayęmi · hankārayęmi · dathushô · Ahurahę · Mazdāo · raęvatô · qarenaghatô · mazishtahęcha · vahishtahęcha · sraęshtahęcha · khraozhdishtahęcha · khrathvishtahecha · hukereptemahęcha · ashāt · apanôtemahęcha · hudhāomanô · vouru-rafnaghô · yô · nô · dadha · yô · tatasha · yô · tuthruyę · yô · mainyush · spentôtemô.* (Yasna I, 1.)

[1] 𐬀𐬵𐬎𐬭𐬀 (Ahura) = Skt. *asura* from rt. *ah*, 'to be.' *Mazdāo* is very differently explained; but the idea of wisdom indisputably underlies the name.

'I declare it, and I venerate the Creator, Ahura Mazda, the Brilliant, Radiant, the Greatest, Best, Most Beautiful, Mightiest, Wisest, Best-formed, Most Exalted through Holiness, Giving Profusely, Granting Much Bliss, Who created us, Who prepares us, Who maintains us, the Most Blissful Spirit.'

In the above are given the principal attributes that constitute the nature of Ahura Mazda.

*He is a Spirit.* He is not anthropomorphous. Though He is represented as speaking, thinking, and acting, no passage of the Avesta authorizes us to assume that Ahura Mazda was thought to exist in any definite visible form. Surely His form could not be compared with that of the human body. The expression 'Best-formed,' *hukereptemahe*, must not be pressed too far, and if, on the other hand, mention is made of 'the most beautiful body of Mazda,' *Sraesh*t*ãm · at · tôi · kehrpem · kehrpãm · avaedayemahi Mazdā Ahurā*[1], we must regard such language as symbolical. For the sun (*hvare*) is expressly spoken of as 'the body of Mazda[2],' and no one could well affirm that this designation should be understood literally. Light is indeed of the essence of Ahura; and hence the sun as the source of perceptible light renders Mazda, so to say, visible Himself.

So early as in the Gāthās Ahura Mazda is very frequently apostrophized as the Blissful Spirit[3]. Anthropomorphisms are exceedingly rare, rarer still perhaps than with the Jehovah of the ancient Jews. When Spentā Ārmati, the protectress of the earth and the genius of *submissive devotion*, is called the daughter of Mazda, it can scarcely be looked upon as a proof of anthropomorphism. It is merely a symbolical expression, which is intended to mean that all good on earth, as also piety of heart, originates from Ahura.

Let us only consider the passage itself:

*At · fravakhshyā · ağheu*sh* · ahyā · vahi*sh*tem ·*
*Ashāt · hachā · Mazdāo · vaẹdā · yē · īm · dāt ·*

[1] Yasna LVIII, 8; XXXVI, 6. [2] Yasht VI, 6.
[3] Yasht XVII, 2; Vendidad XIX, 6.

*Ptarĕm · vaghĕush · verezyantô · managhô ·*
*At · hôi · dugedā · hushkyaothanā · ārmaitish*[1].

'Announce will I the best in this world,
Through Piety I know (Thee), O Mazda, Who created it,
Thee, the Father of the pious and zealously active Mind;
But His daughter is the *Well-behaving Humility*.'

The same can be said of the following passage:

*Pita · te · yô · Ahurô · Mazdāo · yô · mazishtô · yazata nām · yô · vahishtô · yazatanām · māta · ārmaitish spenta brāta · te · yô · vaghush · sraoshô · ashyô · rashnushcha · berezô*[2].

'Thy Father, O Ashi! is Ahura Mazda, the Greatest and Best amongst the Yazatas; thy mother is Spentā Ārmati, thy brother the good Srausha the Holy and Rashnu the Exalted.'

Mention is also made of spouses of Ahura Mazda. Here the names of the spouses show that we have again to deal with a metaphorical mode of expression. The figure is meant to symbolize their close union, their inseparable connection. Hence Ashi and Ārmati may be very appropriately designated in a poetical manner as the spouses of Mazda, while they are elsewhere called his daughters, by a somewhat different figure of speech. Besides the above, we meet with other abstract ideas, such as Blessing, Plenty, and Salvation (*ishem, āzûitîm, frasastîm*[3]), which are also the names of the wives of Ahura.

With particular emphasis fire, the importance of which in the *cultus* of the Mazdayasnān need not be pointed out, is invoked as the son of Ahura Mazda (*ātaremcha · Ahurahe · Mazdāo · puthrem*[4]). It is the holiest and purest element, that which diffuses light. As such it appears to be the earthly and visible image of the Deity, Who is Himself light and absolute purity. A conception just as deep under-

[1] Yasna XLV, 4.
[2] Yasht XVII, 16.
[3] Ys. XXXVIII, 2.
[4] Ys. II.

lies the idea that the sun is the eye of Mazda[1]. This must not be understood too materially, for that would clash essentially with the spirit of the Avesta religion in general. Mazda has his throne above in Heaven, whence He looks with His radiant eye, the bright sun, down upon the earth. His look scares away the darkness, and the demons who lodge in darkness; He also penetrates into the souls of men, and perceives what is good and what is evil in them. Similarly, in the German proverb, 'The sun brings it to light,' the sun symbolizes the Divine Omniscience, which discovers every crime.

*Ahura Mazda is a spirit.* He is a superhuman and transcendent being. His attributes are therefore chiefly spiritual ones. He is the Wise, the Omniscient, the Holy or Pure, the Benign.

In the first Yasht, which is dedicated to Ahura Mazda, which describes His nature, His innumerable epithets are cited. Here He is called Wisdom (*Chisti*sh) simply, or the Wise one (*Chistivāo*[2]). He is named the Observer (*Spa*sh*ta*[3]) Who sees all, the Infallible one (*Adhavi*[4]) Whom nobody can deceive and impose upon. So, too, as early as in the Gāthās:

*Nōi*t · *diwzhaidyāi* · *vīspā-hi*sh*as* · *Ahurō*[5].

'Ahura is not to be deceived, Who has created all.'

*Yā · frasā · avîshyā · yā · vā · Mazdā · peresaitę · tayā ·*
*Yē · vā · kasēu*sh · *ąęnaghô · ā · mazi*sh*tãm · ayamaitę · bûjem ·*
*Tā · chashmēng · thwisrā · hārô · aibî · ashā · aibî · vaęnahî · vîspā*[6].

'The public counsels which take place,
O Mazda Ahura, and the secret ones,
Who imposest the highest penalty for a small one;

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[1] Ys. I, 11 [*Hvarecha · khsh*h*aętahę · aurvataspahę · dōithrahę · Ahurahę · Mazdāo*].

[2] Also *Khratu*sh and *Khratumāo*, Yt. I, 7, 8; also *Zhnāta*, Yt. I, 12.

[3] Yt. I, 13; *Vispa-hishas*, Yt. I, 8.

[4] *Adhavi*, from the root *dab*, *dav*, Yt. I, 14.

[5] Ys. XLV, 4.

[6] Ys. XXXI, 13.

Upon all this Thou lookest as a warder with eyes radiant with holiness.'

Ahura Mazda is also identified with the Best Holiness, with *Asha-vahishta*[1]. 'Holy' and 'Pure' are His constant epithets. All is good in Him, as also only goodness issues from Him. And as the believers in Mazda shall imitate Him, so also they, as the 'pure' or 'holy,' are styled the *Ashavānō*.

But Mazda is also the *Benign*. He is called the Good-giver (*Hudhānush* or *Hudhāoman*[2]). He is not wholly inaccessible to men; the prayers of the pious ascend to Him, and are heard by Him. And there are as many visible earthly gifts for which He is implored, as there are spiritual ones, such as piety and good-mindedness.

*Mazdāo · dadāt · Ahurô · haurvatô · ameretātaschā ·*
*Bûrôish · ā · ashaqyāchā · qā-paithyāt · khshathrahyā · sarô ·*
*Vaghēush · vazdvarē · managho · yē · hôi mainyû · shkyaothanāishchā · urvathô*[3].

'May Ahura Mazda grant well-being and long-life,
Protection of profuse piety and of mastery over one's self,
Power of the good-mind to him, who is devoted to Him in thought and deed.'

*Hvô · zî · ashā · spentô · erekhtem · vîspôibyô ·*
*Hārô · mainyû · ahûbish · urvathô · Mazdā*[4].

'Thou art in holiness the Blissful, Who turns away mischief,
Of all beings, Thou, O Spirit Mazda!'

Though Mazda is thus a spirit, still he stands in close correlation to the world. He is *its Creator*, *its Preserver*, and *Ruler* (*Dātar*, *Pātar*, *Ise-khshathra*).

I have under the section 'The World' given the translation of a sublime Hymn, which praises the omnipotence and

[1] Vt. I, 7, 12. [2] Yt. I, 15; Ys. I, 1.
[3] Ys. XXXI, 21; comp. also Ys. XXXIII, 1(
[4] Ys. XLIV, 2.

wisdom of the Creator[1]. I scarcely know of a passage of the Avesta which can equal it in poetical beauty, though the idea that the entire world, and what is in it, originates from Mazda, and that He has bestowed upon man spiritual graces, is also frequently expressed in other passages. Hence the numerous appellatives, such as Bliss (*Spānô*) simply, or the Blissful (*Spanaghvat, Sevishta*), the Creator (*Dātare*), the Supporter or Preserver (*Thrātar, Pāyu*[2]). Thus Ahura existed even from the beginning, before the world came into existence, which He had called into being by an act of His will, and thus He exists immutable and unchangeable for all eternity.

*Yastā · mantā · pouruyô · raochēbish · rôithwen · qāthrā ·*
*Hvô · khrathwā · dāmish · ashem · yā · dārayat · vahish-tem · manô ·*
*Tā · Mazdā · mainyû · ukhshyô · yē · ā · nûremchît · Ahurā · hāmô ·*
*At · thwā · mēghî · paourvîm · Mazdā · yazûm · stôi · managhā ·*
*Vaghēush · patarem · managhô · hyat · thwā · hēm · chash-mainî · hengrabem ·*
*Haithîm · ashahyā · dāmîm · aghēush · Ahurem · shkyao-thanaeshû*[3].

'He who first conceived the thought: With stars may the effulgent space be clothed!
He through His insight created the Law (the system of the world) whereby He supports the pious;
Thou allowest it to thrive, O Spirit Mazda, Who art the same even now.
Thee chiefly I regard as Him Who must be praised in the mind by men.
Thee as the Father of the pious, for I perceived Thee with mine eyes
As the (true) Founder of the world's system, as the Lord (Commander) of the world through Thy energy.'

[1] Ys. XLIV. 3–5.
[2] Yt. I, 7, 8, 11.
[3] Ys. XXXI, 7–8.

But not merely are the world and its order His work, it is also said of Him:

*Yē · dāt · manò · vahyô · Mazdā · ashyaschā ·*
*Hvo-daenãm · shkyaothanāchā · vachaghāchā*[1].

'Who created the good and holy mind,
And the doctrine, together with the prayers and the works of offering.'

Fire is again most particularly mentioned as the creation and gift of grace of Mazda:

*At · thwā · mēnghāi · takhmemchā · spentem · Mazdā ·*
*Hyat · tā · zastā · yā · tû · hafshî · avāo .*
*Yāo · dāo · ashîsh · dregvāitę · ashāunaęchā .*
*Thwahyā · garemā · āthrô · ashā-aojaghô*[2].

'I will consider Thee, O Mazda, as the strong and the Blissful,
In order that by Thy hand, with which Thou createst help,
The benedictions (might be granted to me) which Thou gavest to the pious as also to the impious
Through the warmth of Thy Fire, the All-Powerful.'

And how Mazda rules over all from the beginning of the world to its end, is expressly described in the following stanza:

*Spentem · at · thwā · Mazdā · mēghî · Ahurā ·*
*Yyat · thwā · aghēush · zāthôi · daresem · paourvîm ·*
*Hyat · dāo · shkyaothanā · mîzdavān · yāchā · ukhdhā ·*
*Akēm · akāi · vaguhîm · ashîm · vaghavę ·*
*Thwā · hunarā · dāmôish · urvaesę · apēmç*[3].

'I thought of Thee as the Blissful, O Mazda,
For I saw Thee as the First at the origin of the world,
For Thou didst create the works of offering, promising reward for them and prayers,
And evil for the vicious, but good blessing for the good,
Through Thy Glory at the dissolution of the world.'

This leads us finally to one power of Ahura Mazda not

[1] Ys. XLVIII, 4. [2] Ys. XLIII, 4. [3] Ys. XLIII, 5.

discussed above, which He exercises in conformity with His Holiness and Justice, and by means of His Omniscience and Infallibility: He is the God, Who rewards the good and punishes the bad, not only in this world in which He sends blessing or misfortune to men, but also at the end of this world, in the next one.

The idea of eternal retribution is so often expressed in the Avesta, that it is not necessary to notice it here more particularly In the section treating of 'Immortality' and the next world, several such passages relating thereto will be found translated.

We thus know that Ahura Mazda is a spiritual being. He is *Wise*, *Holy*, *Just*, and *Benign*. He has created the whole world, so far as it is itself good and faultless, but He also supports and governs it. Before the beginning of the world He existed, and will outlast it. He is the Champion of the Powers of Light against Evil, and will bring victory at the end of the conflict.

In this sublime conception of the Avesta, Ahura Mazda undoubtedly stands far above the deities of the Vedic Pantheon. As already mentioned, only the Jehovah of the ancient Jews may be compared to Him. But however obvious the similarity between the God of Israel and the God of the Mazdayasna may be, still I reject entirely the assumption that the Avesta people have borrowed from the Jews. Upon the Irānian soil a narrowly-confined nation has, independently and of itself, attained that high conception of God, which, with the exception of the Jews, was never attained by any Arian, Semitic, or Tūrānian tribe[1].

[1] ['Spitama Zarathushtra's conception of Ahuramazda as the Supreme Being is perfectly identical with the notion of *Elohim* (God) or *Jehovah* which we find in the books of the Old Testament. Ahuramazda is called by him "the Creator of the earthly and spiritual life, the Lord of the whole universe, in whose hands are all the creatures." He is the light and source of light; he is the wisdom and intellect. He is in possession of all good things, spiritual and worldly, such as the good mind, immortality, health, the best truth, devotion and piety, and abundance of every earthly good. All these gifts he grants to the righteous man, who is

Ahura Mazda does not stand alone. He is also the highest amongst all the spirits; thus He is surrounded by a body of genii or angels, who assist Him in His work, or to whom certain spheres of activity are assigned.

The mightiest and most venerable amongst them are

## II. THE AMESHA SPENTA.

There are six Amesha Spenta. Their name signifies 'the blissful immortal.' The most significant appellatives which they receive are *yavae-ji*, 'living in eternity,' and *yavae-su*, 'blessing in eternity.' Besides they are also called *hukhshathra*, *hudāo*, 'well-ruling, granting good,' or *hvare-hazaosha*, 'of one will with the sun[1].' The last name may indicate that it is their task to create light like the sun. Light however is the symbol of moral purity.

The functions of the Amesha Spenta are also peculiar to the Zoroastrian system of religion. They have been compared with the Vedic Adityas, but without any valid reason. I do not see any cause why a founder of religion like Zarathushtra should not independently have arrived at the idea of joining with the Almighty a circle of angels or ministering spirits.

The names of the Amesha Spenta are perfectly clear. They are abstract and indeed mostly ethical conceptions. They are called:

1. *Vohu-manō*, the good mind.
2. *Asha-vahishta*, the best holiness.
3. *Khshathra-varya*, the desirable sovereignty.
4. *Spentā-Ārmaiti*, humble sense.
5. *Harvatāt*, well-being, happiness, health.
6. *Amertāt*, long-life, immortality.

The abstract meaning is everywhere so clearly per-

upright in thoughts, words, and deeds. As the ruler of the whole universe, he not only rewards the good, but he is a punisher of the wicked at the same time (see Yas. XLIII, 5). All that is created, good or evil, fortune or misfortune, is his work (Yas. XLVIII, 4, and LI, 6). *Vide* M. Haug, *Essays*, p. 302.—*Tr. note*.]

[1] Ys. XXXIX, 3: II, 2; Yt. X, 51; XIII, 92.

ceptible, that by that alone the distinct position of the Amesha Spenta is established, if contrasted with the genii of other religious systems. The double meaning is so marked, that we might really translate in a double way many verses of the Gāthās, in which the names of the Amesha Spenta occur, at one time in the abstract, and at another in the personal signification of their names.

In the Gāthās themselves, Ahura Mazda is frequently invoked together with the Amesha Spenta, particularly with Vohu-manō, Asha, Khshathra, and Ārmati.

*Yē · vāo · Ashā · ufyānî · manaschā · vohū · apaourvîm ·*
*Mazdāmchā · Ahurem · yaeibyô · khshathremchā · agzhaonvamnem ·*
*Varedaitī · Ārmaiti*sh *· ā · môi · rafedhrāi · zaveñg · jasatā*[1].

'You both will I praise, Asha and Vohu-manō the incomparable,
And Mazda Ahura, and together with them the imperishable Khshathra,
And the blessing-dispensing Ārmati come hither at my invocation!'

*Dāidî · ashā · tām · ashîm · vaghêu*sh *· āyaptā · managhô ·*
*Dāidî · tû · ārmaitî · vi*sh*tāspāi · aeshem · maibyāchā ·*
*Dāostû · Mazdā · khshayāchā · yā · vē · māthrā · srevîmā · rādāo*[2].

'Grant, O Asha! this blessing, together with the gift of grace of Vôhû-manō;
Grant Thou, O Ārmati! to Vishtāspa his wish and to me;
Grant Thou, O Mazda! Thou Powerful, that we may proclaim your words as channels of grace!'

*Ahmāichā Khshathrā · jasat · managhā · vohû · ashāchā ·*
*At · kehrpem · utayûiti*sh *· dadāt · ārmaiti*sh *· ānmā*[3].

'But towards us He (Mazda) turned, together with Khshathra, Vohu-manō, and Asha;
Strength created the body, but Ārmati gave prosperity.'

[1] Ys. XXVIII, 4. [2] Ys. XXVIII, 8. [3] Ys. XXX, 7.

From these examples we observe that Mazda and the first four Amesha Spenta are indeed the most ancient constituent parts of the Zoroastrian system, that these genii form, so to say, the basis upon which the whole structure rests. Or can it be a mere accident that just the most sensuous and the most humanly-conceived *yazatas*, Mithra and Anāhita, are scarcely mentioned in the Gāthās!

Let us now examine each individual Amesha Spenta.

Each of them has a definite field of activity in the visible world also, while Ahura holds the supreme direction of all that exists To Vohu-manō is entrusted the protection of herds; to Asha, that of fire; to Khshathra, that of metals; to Ārmati, the guardianship of the earth; lastly, to the genii, Harvatāt and Amertāt, the protection of waters and of plants. The intrinsic relation between the abstract signification of each individual name and the material functions, which the respective genius always discharges, may, I think, be further proved. Such proof I shall now endeavour to furnish.

That VOHU-MANŌ, *the good-mind*, is also the protector of herds, is explained from the social circumstances under which the Zoroastrian religion developed itself in the very oldest periods. At that time a great portion of the people still led a nomadic life. Others had established permanent settlements; they cultivated the fields, and attended to the rearing of cattle. Amongst the latter the new doctrine found access; *they* were the 'pious' and 'good-minded ones.' The life of a good mind was at the same time the life of peaceful herdsmen and peasants. We have passages in the Gāthās where we may translate Vohu-manō directly by 'herds:'

*At · hî · ayāo · fravaretā · vāstrîm · aqyāi · fshuyañtem ·*
*Ahurem · ashavanem · vaghēu*sh *· fshēñghî · managhô ·*
*Noit · Mazdā · avāstryô · davāschinā · humaretôi*sh *bakh*sh*tā*[1].

'But she, the Cow, selected of those two the laborious countryman,

[1] Ys. XXXI, 10.

To be her pious lord, the protector of herds (or, of *the good-mind*);
But he who did not follow agriculture, O Mazda! did not participate in the good religion, though he attempted to deceive.'

The ambiguity of the Gāthā texts is thus actually increased, since we have now, for one single idea, the choice between a personal, an abstract, and a material translation.

That Vohu-manō was, however, not merely regarded as the guardian of herds, but of living beings in general, especially of men, may be perceived from the nineteenth Fargard of the Vendidād, where the word *vohu-manō* is to be rendered directly by 'man.'

Vohu-manō is the first amongst the Amesha Spenta. These are therefore spoken of as 'those who dwell together with Vohu-manō' (*Yōi* · *vaghēu*sh · *ā* · *managhô* · sh*kyęinti*[1]). He plainly appears as their chief and spokesman, when he is in Paradise. As soon as a soul approaches, he rises from his 'golden throne,' addresses it, and shows it the place allotted to it[2].

ASHA-VAHISHTA, *the best piety or purity*, is at the same time the genius of fire. The reason of this lies in the fact that fire is the symbol of purity. Nowhere does the double nature of Asha more clearly appear than in the passage where Angra Manyu plaintively exclaims:

*Tāpayeiti* · *mãm* · *asha* · *vahi*sh*ta* · *mānayen* · *ahę* · *yatha* · *ayaokh*sh*ustem* · *raekô* · *mę* · *hacha* · *aghāo* · *zemat* · *vaghô* · *kerenaoiti* · *yō* · *mãm* · *aęvô* · *jāmayęiti* · *yô* · *Spitâmô* · *Zarathu*sh*trô*[3].

'He burns me with the *Asha-vahishta* (the Holy Fire), like red-hot metal; he best drives me from the earth, he, who alone makes me fly, is the son of Spitama, Zarathushtra.'

KHSHATHRA-VARYA, *the desirable sovereignty*, is a being not very clearly defined. To him is entrusted the care of metals. We trace the same idea in the Avesta itself.

[1] Ys. XXXIX, 3. [2] Vendidad XIX, 32. [3] Yt. XVII, 20.

when *khshathra-vairya* is plainly used for '*metal*[1]' or for '*a metallic instrument, knife*[2],' just as we have seen *vohu-manō* also denoting '*herds*,' and *asha-vahishta* '*fire*.' In what connection the ideal and material functions of Khshathra stand to each other, I cannot explain.

Spentā Ārmati is of far more interest to us. This angel plays also in the Avesta a part dissimilar to and far more independent than those mentioned above. The name literally denotes '*moderate thinking*,'—the mind which always keeps itself within the bounds of what is right and good. By this is not only to be understood wisdom, but even more, *humility and quiet resignation to the will of God*[3].

Materially, Spentā Ārmati is the protectress of the earth. This part of her nature appears most clearly in the legend of Yima, according to which, when under that king, men, beasts, and fire (i. e. hearths) had multiplied themselves, and the earth had become too narrow for them, he uttered the following prayer:

> *Fritha · spenta · ārmaitę · fracha · shava · vîcha · nemagha · barethre · pasvāmcha · staoranāmcha · mashyānāmcha · Âat · yimô · imām · zām · vîshāvayat · aeva · thrishva · ahmāt · masyęhîm · yatha · para · ahmāt · as*[4].

> 'Beloved Spentā Ārmati, extend and widen thyself, thou *mother of cattle and of men*.' 'Thus he (Yima) caused the earth to extend, whereby it became one-third larger than it was before.'

It is evident that Yima here addresses himself to Ārmati,

[1] Vend. XVI, 6, *ayaghaęnem · vā · srum · vā · nitema · khshathra-vairya.*

[2] Yt. X, 125; Vd. IX, 9.

[3] This appears clearly from the mere name of the demon *Tarômaiti* (formally and materially an opponent of *Ārmaiti*), evidently 'arrogance.' And the verbs '*tarem-man*' and '*arem-man*,' in Ys. XLV, 11, have opposite meanings. I believe that *Ārmati*, as it follows hence, is contracted from '*arem-maiti*.'

[4] Vend. II, 10, 11. Also Ys. XVI, 10, where *Ārmati* denotes '*maęthana*,' 'a dwelling-place,' might be referred to for comparison

as the genius of the earth. As such Ārmati alone can be distinguished by the epithet '*bearer*' or '*mother*.' In quite the same way it is said of the earth itself: 'Together with other women we praise this Earth, who bears and nourishes us[1].' Here the Earth is undoubtedly viewed as a person, and the author might as well have said '*Speṇtãm Ārmaitîm*' as '*imãm zãm*.' Along with this idea an explanation is also at the same time given as to how humility could be made to be the protection of the earth This comes from regarding the earth chiefly as the humble, suffering one, which bears all, nourishes all, and sustains all.

Moreover Ārmati is the only figure amongst the Amesha Spenta that may be traced as a personal deity to the Arian (Indo-Irānian) epoch. In the Rig-veda, Ārmati is found to be *devotion* or *genius of devotion*, and it is characteristic that just here in the Vedas also, as very often in the Avesta, we cannot with certainty separate the abstract from the personal signification. By the Indian commentator Sâyana, Ārmati (Skt. *aramati*) is regarded as *Wisdom*, but, strange to say, he also defines the same word twice as 'the Earth[2].'

HARVATĀT and AMERTĀT[3] form an inseparable pair. Their names signify '*invulnerability, good-preservation, health*,' and '*undying long-life, immortality*.' They rule over the water and over plants. The Avesta does not, however, indicate this directly; but we have for it the testimony of Neriosengh, which does not contradict in any way the brief indications contained in it (the Avesta). In the Avesta, also, water and plants are always coupled together[4].

[1] Ys. XXXVIII, 1, *imãm · ãat · zãm · genãbîsh · hathrã · yazamaide*. In the designations that follow, the '*genão*' is on another occasion specially called '*ãrmaiti*sh.'

[2] Grassman, *Worterbuch* sub voce; Spiegel, *Erãnische Alterthumskunde*, vol. ii, p. 38.

[3] Comp. Darmesteter, *Haurvatãt et Ameretãt*, in the *Bibliothèque de l'école des Hautes Etudes*, xxiii, 1875.

[4] Yt. XV, 16; XIX, 32. Comp. Yt. XIII, 93, 94, where water and plants (*ãpõ · urvarãosca*) begin to increase with Zarathushtra's birth.

The following invocation to these two genii is characteristic:

*Haurvatâtem · ameshem · spentem · yazamaide · yâiryãm · hushitîm · yazamaide · saredha · ashavana · ashahe ratavô · yaz ... Ameretâtem · ameshem · spentem yaz ..fshaoni · vâthwa · yaz ... aspinâcha · yavînô · yaz ..gaokerenem · sûrem · Mazdadhâtem · yaz* ...[1]

'We praise Harvatât, the Amesha Spenta; we praise the yearly good dwelling, and the years, the holy masters of holiness. We praise Amertât, the Amesha Spenta; we praise the fields and herds; we praise the tree *Gaokerna*, the strong one, which Mazda created.'

Here Harvatât rules over habitations, for every permanent dwelling-place, particularly in the arid district of Eastern Irân, is dependent upon the presence of sufficient water. Amertât rules over the fields and herds, since he causes the plants to germinate, and over the tree Gaokerna, which is itself the king of plants, and which gives immortality.

The connection between the abstract and the material meaning is not so clear in the case of any other Amesha Spenta as in that of Harvatât and Amertât. Harvatât, '*health*,' is therefore the master of water, for the waters are considered as dispensing health.

*Yayata · dunma · yayata · frâ-âpem* ...... *yaskahe · apanash*t*ahę · mahrkahe · apanash*t*ahe*[2].—*Yô · vô · âpô · vaguhî*sh *· yazâitę · ahurânî*sh *· Ahurahe* ....... *ahmâi* ...... *tanvô · dravatâtem* ......[3]

'Come, ye clouds, with your waters ...... to drive away sickness, to drive away death.'—'Whosoever offers to you, you good waters, you daughters of Ahura ...... on him you bestow ...... health of body' ......

Something similar we learn of the plants. At the request of Thrita, Ahura Mazda causes the wholesome plants .....

[1] Sirozah II, 6, 7.

[2] Vend. XXI, 2.

[3] Ys. LXVIII, 10, 11

to sprout, 'in order to dispel sickness and death[1].' It is especially the Haoma plant which is commended as salutary: it keeps away death, and confers health of body and a long duration of the vital power[2]. In conclusion, we may call attention to the White Haoma, the enjoyment of which confers immortality.

In *one* word. water and plants bestow health and long life, happiness and immortality. Hence the conceptions of '*health*' and '*immortality*,' which are exalted into personal genii. Harvatāt and Amertāt are their commanders, and form, like the latter, an inseparable couple.

## III. THE ELEMENTS AND ELEMENTARY *YAZATAS*.

We have already recognized in Asha-vahishta an Amesha Spenta of fire, and in Harvatāt an Amesha Spenta of water. Both these elements play an important part in the Avesta. But it is difficult to distinguish in individual instances, whether we should accept the personal or the material signification, whether we are on the domain of religion or on that of the *cultus*.

What a wide space the *cultus* of fire occupies amongst Zoroastrians need not be mentioned. I have myself discussed it in the section on 'Prayers and Household Customs.' For my part I can hardly doubt that fire was conceived also as a *yazata*, but where the element alone is meant and where the *yazata* cannot be determined without difficulty; the lack of tangible materiality of shape in these *yazatas*, the constant clinging to the mere idea by which the entire Avesta is distinguished, appears here more manifestly prominent than anywhere else.

Fire is conceived as half personal and half material when at night it awakens a man from sleep and impels him to

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[1] Vend. XX, 3 [*paitishtātēę · yaskahe · paitishtatēę · mahrkahę*].

[2] [*Baęshazya, duraosha—dravatātem · tanvô, dareghô-jîtîm · ushtānahę.* Ys. IX, 6, 2, 4, 19.]

add fuel, so that it may not die out. The correct tendance of fire is accompanied simultaneously by a blessing[1].

The same sort of double meaning is met with when, with the several invocations at the beginning of the Yasna-ceremony, it is said: 'We invite *thee*, O Fire, thou son of Ahura Mazda!'[2] Here the fire is undoubtedly intended to represent a *yazata*, but at the same time the priest, as is already manifest from the direct manner of address, has in view the holy fire, which burns before him upon the altar.

When it is said that the Fire and Vohu-mano stood up against Angra Manyu in order to check the injuries he was inflicting, Asha-vahishta may be directly meant by the Fire[3].

Fire appears most thoroughly personified in the passage where it is named together with Vohu-manō and Asha-vahishta as an opponent of Dahāka:

> *Yahmi · paiti · pareqāithe · spentascha · mainyu*sh *· ağras-cha · aetahmi · paiti · at · aqaretę · adhāt ·* ash*te · frağ-harechayat · āsi*sh*te · kataraschit. Spentô · mainyu*sh *·* ash*tem · frağharechayat · vohucha · manô · ashemcha · vahi*sh*tem · ātaremcha · Ahurahę · Mazdāo · puthrem · ağrô-mainyu*sh *·* ash*tem · frağharechayat · akemcha · manô · aęshmemcha · khravîdrûm · azhîmcha · dahā-kem · spityuremcha · yimo-kerentem. Adhāt · frasha · hām-rāzayata · ātar*sh *· Mazdāo · Ahurahe · uiti · ava-tha · mağhânô · aetat · qarenô · hangerefshāne · yat ·*

[1] ['Arise, thou master of the house! put on thy garments, wash thy hands, long for some wood for me, bring it unto me, kindle the clean wood over me, with both thy well-washed hands.' After this address, the Fire blesses the man, who brings him dry wood with a righteous heart, in the following words: 'May herds of oxen follow thee, and of heroic sons in plenty: may thy mind develop through action, may thy soul develop through energy: all the (days and) nights that thou livest, mayest thou live in the delight of thy soul.' Vend. XVIII, 19, 27; Ys. LXII.—*Tr. note.*]

[2] *Nivaędhayemi · hankārayęmi · āthrô · Ahurahę · Mazdâo · puthra.* Ys. I, 12; II, 12; III, 14; IV, 17.

[3] [*Yat · titarat · ağro · mainyu*sh *· dahêm · ashahę · vağhêu*sh *· antare · pairi-avātem · vohucha · manô · ātar*sh*cha.*] Yt. XIII, 77.

*aqaretem. Āat · he · paskāt · fradvarat · azhi*sh · *thrizafāo · duzhdaenô · uta · zakhshathrem · daomnô.*

*Inja · avat · handaesayag̃uha · ātar*sh · *Mazdâo · Ahurahe · yezi · aetat · nyāsāog̃he · yat · aqaretem · frā · thwām · paiti · apātha · nôit · apaya · uzraochayāi · zām · paiti · Ahuradhātām · thrāthrāi · ashahe · gaethanām*[1].

'For the heavenly radiance fought the Blissful, and the Destructive Spirit for the imperishable. Then both of them sent forth their speediest messengers. The Blissful Spirit sent out as messengers Vohu-manō and Asha-vahishta, and Fire, the son of Ahura Mazda. But the Evil Spirit sent forth as messengers Akem-manō, and Aeshma with bloody lances, and Azi Dahāka, and Spityura who sawed to pieces Yima. Then flamed up the Fire of Ahura Mazda, thinking, "I will seize for myself the heavenly splendour," but behind him ran the three-headed evil dragon striving for his destruction.

*Ho there! let me see thou Fire of Ahura Mazda; if thou withholdest it from me, then will I not let thee shine in future upon the earth, which Mazda created for the protection of pious men.*'

Now the Fire lets the heavenly radiance slip from his hands. Dahāka takes possession of it, but the Fire compels the Demon to surrender again the heavenly splendour, which is secured in the sea Voru-Kasha.

Here Fire is introduced as thinking, speaking and acting: it is a personal *yazata*. But in most cases we have to do only with the mere element itself. Thus, for instance, when the fire is divided into different classes. So too the *hvareno*, 'the heavenly radiance,' is very likely an attribute of the Deity, but not a deity itself. On the other hand we can fairly conceive Naryo-sag̃ha as a *yazata* of fire.

NARYO-SAG̃HA is the messenger of Ahura Mazda[2], just as the Vedic Indians designate the fire-god, *Agni*, as the

[1] Yt. XIX, 46–48.

[2] Vend. XIX, 34: *ashto · Mazdāo · Ahurahe*; or perhaps *astō* (?) 'the embodying of Mazda.'

'messenger' of gods[1]. Indeed the Deity sends down the fire from heaven, as lightning or sun-fire, to the earth, while on the other hand the fire burning upon the altar carries upwards the prayers and gifts of men to God.

Naryo-sağha together with Srausha is the companion of Mithra[2]. He bears a club, by which the flash of lightning is probably to be understood. In the Brahmanical hymns also the genii fighting in the brunt of the battle are armed with clubs. It is for once allowable, in the present case, to introduce Vedic incidents for comparison, for even the name of Naryo-sağha is found under the almost literally similar form *Naraçamsa,* as an appellative of the fire-god Agni.

Apãm-napāt forms the transition from the *fire-yazatas* to the *water-yazatas.* The name signifies '*son of the waters,*' and must have originally designated the flame of lightning, so far as it dwells in the clouds and is born of the clouds. For that reason Apãm-napāt is invoked with Naryo-sağha, who is however undoubtedly a fire-yazata, but often also with the waters to which he stands in close relation[3].

In the Vedic hymns also Apãm-napāt is mentioned. This deity was thus invoked by the Arians even before Zarathushtra established his new doctrine. There too he is the fire of lightning dwelling in the clouds. Here the virgin waters foster and nourish him, until he bursts forth out of the clouds in bright-shining lustre. In quite a similar way is Apãm-napāt pictured in the Avesta:

> *Berezantem · ahurem · khshathrîm · khshaetem · apãm-napātem · aurvat-aspem · yazamaidę · arshānem · zavanôsũm · yô · nerĕu*sh *· dadha · yô · nerĕu*sh *· tatasha · yô · upâpo · yazatô · srut-gaoshôtemô · asti · yazemnô*[4].

'The great lord, the king-like, bright Apãm-napāt with his war-steeds, we praise, the *hero* who blesses invo-

[1] *Dūta,* Rig-veda I, 44, 2; I, 72, 7, and frequently elsewhere.

[2] Yt. X, 52. Along with Srausha we also find the name of Naryo-sağha in Ys. LVII, 3.

[3] Ys. LXXI, 23; Ys. I, 5; II, 5, &c. Even the epithet 'shining' (*khshaeta*) characterizes Apãm-napāt as a fire-yazata.

[4] Yt. XIX, 52.

cation, who made men, who formed men, who, the yazata of the waters, listens most propitiously when he is invoked.'

Here we observe that Apãm-napāt, according to the Zoroastrian idea, participates in the work of the creation; the formation of men is specially ascribed to him. This also corresponds again with the Vedic conceptions of Apãm-napāt, of whom it is said: 'The son of the waters, in the strength of his deity, benignly created all the creatures[1].'

Even when it is said,

> *Apãm-napāose · tāo · āpô · Spitama · Zarathushtra · aguhe · astavaite · shôithrô-bakhtāo · vîbakhshaiti · vātascha · yô · darshish · awzh-dātemcha · qarenō · ashaonãmcha · fravashayô*[2],

> 'Apãm-napāt spreads the waters given to the fields, O son of Spitama! Zarathushtra! upon the corporeal world, and Vāta (*the wind*) the strong one,'

I do not consider Apãm-napāt to be a *water-yazata*. This may only mean that with the flashing of lightning (Apãm-napāt) and the roar of the stormy-wind (Vāta) the fertilizing rain pours down upon the earth.

If now we proceed to speak of the waters themselves, we again stand more upon the ground of *cultus* than upon that of religion. The importance of water for life and culture in Eastern Irān, I have frequently enough and pointedly alluded to in the course of my 'History of Civilization.' It is therefore conceivable that this element stood in high veneration. But also in invocations such as the following,

> *Nivaędhayęmi · hankārayęmi · aiwyô · vaguhibyô · vîspanãmcha · apãm · Mazdadhātanãm · vispanãmcha · urvaranãm · Mazdadhātanãm*[3],

> 'We announce it, and invite the good waters, all waters which Mazda created, and all the plants which Mazda created,'

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[1] Rig-Veda II, 35, 2.
[2] Yt. VIII, 34.
[3] Ys. I, 12.

water is only meant as an element. To the dignity of a *yazata* it is not exalted.

The proper *water-yazata* is ARDVI-SŪRA ANĀHITA.

The veneration of this female *yazata* is a special property of the Irānian religion, and has its history. For I believe that Ardvi-sūra was originally the name of a large river, the Oxus. This appears very clearly in certain descriptions and eulogies of the Avesta

(*Ardvīm* · *sûrām* · *anāhitām* · *yazamaide*) · *yā* · *asti* · *avavaiti* · *masô* · *yatha* · *vīspāo* *imāo* · *āpô* *yāo* · *zemā* · *paiti* · *fratachanti* *yā* · *amavaiti* · *fratachaiti* · *hukairyât* · *hacha* · *berezaghat* · *avi* · *zrayô* · *vouru-kashem* · *yaozenti* · *vīspe* · *karanô* · *zrayā* · *vouru-kashayā* · *ā* · *vīspô* · *maidhyô* · *yaozaiti* · *yat* · *hīsh* *avi* · *fratachaiti* · *yat* *hīsh* · *avi* · *frazhgaraiti* *ardvī* *sūra* · *anāhita* · *yeghe* · *hazagrem* · *vairyanām* · *hazagrem* · *apaghzhāranām* · *kaschitcha* · *aeshām* · *vairyanām* · *kaschitcha* · *aeshām* · *apaghzhāranām* · *chathwāresatem* · *ayare-baranām* · *hvaspāi* · *naire* · *baremnāi*[1].

'(The Ardvi-sūra Anāhita we praise), which is as large as all other waters that flow over the earth, which powerfully streams down from the *Mount Hukarya* into the sea *Voru-kasha*. All the shores are covered with waves, all the middle heaves up in the sea *Voru-kasha*, when into it streams down, when into it flows, the Ardvi-sūra Anāhita. That has a thousand arms and a thousand canals; and each of these arms and each of these canals is as long as forty days' journey for a well-mounted man.'

We have here undoubtedly the picture of a mighty river of great volume, with many tributary streams and branches. But if we look to the original dwellings of the Avesta people, as they appear from the geographical indications of the text, there is no doubt that 'Ardvi-sūra' can mean only the Oxus; for which on the opposite supposition we would have no designation at all. At the same time the name

[1] Yt. V, 3, 4; Ys. LXV, 3, 4.

Ardvi-sūra Anāhita does not merely designate the stream by itself, but also the *yazata* to whom the stream is dedicated, and who rules over it. Hence these words can be put into her mouth:

> *Mana · raya · qarenaghacha · pasvascha · staorācha · upairi · zām · vîcharenti · mashyācha · bizangra · nipayemi · vîspa · vohû · Mazdadhāta (asha-chithra) mānayen · ahe · yatha · pasûm · pasu-vastrem*[1].

> 'Through my riches and my splendour, sheep and cattle wander on the earth, and two-legged men. I protect for them all the good things which Mazda created, just as a fold shelters (or as the fleece protects) the flock.'

From the *yazata* of the largest and holiest stream to the *yazata* of water in general there is indeed only a small step.

Ardvi-sūra Anāhita is one of those *yazatas* in the Avesta who were most completely moulded into a tangible personality. As a female *yazata*, Anāhita is also especially the guardian of the female sex. Her work in that respect is described in the following passage:

> *Yā · vîspanām · arshnām · khshudrāo · yaozhdadhāiti · yā · vîspanām · hāirishinām · zāthāi · garewān · yaozhdadhāiti · yā · vîspanām · hāirishîsh · huzāmitō · dadhāiti · yā · vispanām . hāirishinām · dāitîm · rathwîm · paęma · ava-baraiti*[2].

> 'That governs the generation of all men (lit., purifies the seed of all men), that prepares the bodies of all women for delivery, that gives sufficient and well-timed milk to all women.'

To the fire and water *yazatas* may be added without hesitation VAYU or RĀMAN, and VĀTA, the *yazatas* of the air and the storm-wind.

Like all *yazatas* of nature, Vayu and Vāta are also thrown into the shade in the Avesta. The latter is designated 'the strong one,' and 'created by Mazda[3];' further than

[1] Yt. V, 89. [2] Yt. V, 2.
[3] Vend. XIX, 13; Ys. XLII, 3.

this we learn nothing particular about him. Vayu occupies a somewhat larger space, and is called the strong and the swift one. The influence of Vayu is tolerably extensive however one can scarcely say whether it stands in closer relation to his nature as the *yazata* of the air or as that of the wind. Unmarried maidens pray to him for husbands who may take care of them and beget offspring by them[1] His name, however, is also invoked in the heat of battle with hostile armies, when violent tyrants reign in the land. when heretics attack the purity of religion, or when a person is betrayed into the hands of his enemy[2].

On the whole, Vayu may be characterized as the strong, robust, warlike helper in every danger. With man and horse he drives away anxious fear and suspense, he drives away the demons[3], and hence it is said of him .—

> *Vayush · aurvô · uskāt · yāstô · derezrô · yaokhdhrô · berezipādhô · perethu-varô . . . anākhrûidha-dôithra · yatha · anyāoschit · khshathrāt · khshayamnāo · hamô-khshathrô-khshayamnāo*[4].

'Vayu is armed and warlike, powerful, martial, high-footed, with a wide chest, and a tender glance, like the others that rule over kingdoms as sovereigns.'

## IV. STAR-YAZATAS.

Amongst the *star-yazatas*, the SUN (*Hvare*), the MOON (*Māogha*), and the 'BEGINNINGLESS STARS' (*Anaghra Raochāo*), deserve to be first considered. The rain-star TISHTRYA is also worthy of mention, and in remote relation to them stand also the FRAVASHIS, the *manes* or spirits of the defunct, so far at least as they were apparently considered to be stars

I can and indeed must express myself only briefly upon this subject, since I have had occasion to discuss it in my 'History of Civilization,' in the section upon '*The World.*'

[1] Yt. XV, 39.
[2] Yt. XV, 49–52
[3] Yt. XV, 53.
[4] Yt. XV, 54.

The SUN, as the bearer of light, is the chief opponent of the demons. He is *the eye of heaven, the eye of Ahura Mazda.* The *Yazata of the Sun* is represented as driving in a bright shining chariot which is drawn by celestial horses.

The MOON is the lamp of the night. To her is ascribed a mysterious influence upon the growth of plants. Deserving of attention is her constant epithet *gaochithra*, 'containing the seed of cattle,' by which is perhaps indicated her influence upon the increase of herds.

By the name BEGINNINGLESS LIGHTS are probably meant the stars. Amongst them *Tishtrya* is the principal one. He is Sirius in the constellation of Canis Major. The veneration in which he is held is connected with the fact that he first rises in midsummer, and that the longer he remains in the heavens the sooner the heat will diminish and the autumnal rain appear instead of sultry weather and barrenness.

Thus Tishtrya becomes the dispenser of rain. It is he who opens the heavenly fountains, and thereby increases the waters in springs and rivulets, in rivers and in seas. His opponent is the demon of heat, APAUSHA, whom he conquers after a desperate combat. The helper of Tishtrya in the work of distributing the waters over the earth is the star SATAVAISA, which I believe to be Vega in the constellation of Lyra.

With the FRAVASHIS, the *manes*, we are again concerned more with the *cultus*. I have devoted a special chapter to the *cultus of the manes*. They are helpers in every necessity and danger. They protect habitations, supply them with water, and cause them to attain prosperity. They are helpers in war, and assist in the maintenance and preservation of the world's system and its laws. That they are regarded as stars is apparent from the description of them as wandering through the height of the firmament with a celestial escort.

## V. ABSTRACT IDEAS AS NAMES OF SPIRITUAL BEINGS.

The Avesta religion differs essentially from the religion of kindred nations, more particularly in the fact that in it the sensible and the material appear to fall into the background when opposed to the purely spiritual, ethical, and ideal. The names of the six Amesha Spenta, the highest spiritual essences of the entire system, are indeed all abstract ideas, and are, moreover, still employed as such in the sacred writings.

Thus it cannot surprise us, if in addition a whole series of abstract ideas and ethical conceptions are formed into holy names, into more or less personal angels.

I shall not here discuss the fact that in the prayers and invocations of the Avesta are also named the *Daena*, the *Holy Doctrine*, *The Law*, or *Māthra Spenta*, the *Holy Word*, or *Sauka* probably 'the Blessing.' They were exactly things which appeared in themselves worthy of veneration and at the same time desirable. If, therefore, any one in praying invokes them, or rather desires their coming, it is not thereby implied that they are real *yazatas*. Indeed it is difficult to draw the necessary distinction.

Such an abstract idea is ARSHTĀT or ARSHTI, who is invoked together with RASHNU[1]. Both these *yazatas*, as the etymological connection of their names of itself indicates, appear to be essentially cognate.

Rashnu, however, is undoubtedly the genius of justice. He is called *ashavan* 'the holy,' *razishta* 'the just,' *vaidhishta* 'the knowing,' *vichôistare* 'the discerning,' he who also perceives what is remote, *durae-darshtema* 'the far-seeing[2].' In short he is the *yazata* before whose penetrating eye nothing lies hidden. It may therefore be easily understood that he is a particular enemy of thieves, and above all

[1] Ys. I, 7; II, 7.

[2] Yt. XII, 7. *Vichôistare* from the root *vi* + *chit*; *paraka-vistema*.

of wicked men, whose deeds shun the light of day[1]. It is likewise clear why Rashnu appears amongst the Judges of the Dead. It is he who weighs the good and the bad deeds of each soul against each other, and who always passes sentence according to the result.

We will hardly err, therefore, in looking upon Arshtāt simply as 'Justice' personified.

The number of the abstract ideas in which, according to the doctrine of the Avesta, a certain sanctity is involved, and which therefore occur in invocations along with active and personal *yazatas*, is rather considerable. Many of them are not quite clear. Amongst the doubtful ideas I reckon UPARATĀT, perhaps 'Victory,' next DĀMOISH UPAMANA, about which I can say almost nothing for certain, then ĀFRITI 'Benediction' of pious men, possessing divine strength and efficacy, and lastly RASĀSTĀT, probably again something similar to Justice, and others.

VERTHRAGHNA, SRAUSHA and ASHI-VAǦHVI are of a more definite character.

Verthraghna is without doubt 'Victory' or 'the *yazata* of victory.' This is quite evident from his being chiefly invoked in battle:

> *Kva · asti · verethraghnahe · Ahuradhātahe · nāma · azbāiti*sh? *kva · upastūiti*sh? *kva · nistūiti*sh? *Yat · spādha · hanjasāontę · ra*sh*tem · rasma · katarasch it ·* vish*tāoghô · ahmya · nôit · vanyāontę · jatāoghô · ahmya · nôit · janyāontę . . . yatārô · pourvô · frāyazāitę · amô · hutā*sh*tô · huraodhô · verethraghnô · Ahuradhātô · atārô · verethra · hachaitę*[2].
>
> 'When occurs the invocation of the name of Verthraghna? When his praise? When his (conjuration) hearing? When armies dash against each other, drawn up in battle array, then to one of the two, not conquered, not smitten . . . who first invokes the well-created, well-formed Strength, Verthraghna, whom Ahura created: to his lot the victory falls.'

It is he, who 'commands amongst the lines of battle

[1] Yt. XII, 7, 8.

[2] Yt. XIV, 42, 43.

arrayed for the fight[1].' It is he, who 'crushes the battalions, who separates and smites them, who shakes them violently[2].'

He ties behind them the hands of the breakers of covenants, he blinds their power of vision, he deafens their ears, and unnerves their feet, so that they cannot offer any resistance[3].

It is remarkable that Verthraghna is also pictured 'in the form of a rich man who carries a sword with a golden hilt, a jewelled, an embellished and a richly ornamented one[4].'

Finally, we must notice that he is identified with Vāta, the boisterous storm-*yazata*[5]. This carries us back to Indra, the *Vritrahan* of the Rig-veda, the god who fights in storm and thunder against the demons. Evidently Verthraghna may be traced to such a natural deity of the Indo-Irānian epoch, with this difference that that god was transformed after the Zoroastrian manner of thinking. His functions as a nature-god were lost sight of. Verthraghna is, according to the Mazdayasnān belief, no longer the fighter in the thunder-storm, but in general the genius of victory, and the pious are indebted to his help, if they overpower the unbelieving in battle.

A most characteristic figure in the Avesta religion is SRAUSHA. He too exemplifies clearly the ethico-philosophical spirit which predominates in the Zarathushtrian system. Srausha means 'obedience,' and especially obedience towards the Holy Word and its Commandments. Hence Srausha is the principal opponent of the demons, who endeavour to lead man to violate those commandments and to neglect his religious duties.

Ahura Mazda has created Srausha as the opponent of *Aishma*, the demon of 'violent wrath[6].' Whoever follows

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[1] [*Yô · vīrāzaiti · antare · rāshta · rasmana*] Yt. XIV, 47.

[2] [*Yô · rasmanô · schindayeiti · yô · rasmanô · kerentayeiti · yô · rasmanô · qaghayeiti · yô · rasmanô · yaozayeiti.*] Yt. XIV, 62.

[3] Yt. XIV, 7–25.

[4] [*Verethraghnô · vīrahe · kehrpa · raevatô · barat · karetem · zaranyô-saorem · frapikhshtem · vīspo-paesaghem.*] Yt. XIV, 27.

[5] Yt. XIV, 1, 2.

[6] Yt. XI, 15 (Comp. also Ys. LVII, 10), *aeshmahe · hamaestārem.*

the Zoroastrian Law must suppress the passion of anger. Srausha is, besides, the adversary of *Bushyāsta*, the evil spirit of 'indolence,' who, in the morning, entices man to give himself up to sleep[1]. 'Obedience' to the Law requires us to wake early and to set about our daily business; for even in the morning a series of ritual and religious duties await the Worshipper of Mazda. Similarly Srausha fights against the demons of 'drunkenness[2],' for the doctrine of Zarathushtra demands a frugal, prudent life.

If the name of Srausha means obedience to the Holy Law, it is very easy to explain why the introduction of certain ritual precepts is ascribed to him It is he, who first of all recited the sacred hymns, who first tied together the *Baresma*, the consecrated sacrificial branches, in honour of Ahura Mazda, the Amesha Spenta, and Mithra; but he is also expressly styled the Teacher of the Law[3]. It is likewise intelligible why the holy prayers are the weapons with which he conquers the demons[4].

In other respects also the power of Srausha is naturally explained from that *single* point of view. Srausha pities the poor and the needy, since the Law commandeth charity towards the members of the same faith. He guards, like Mithra, the sanctity of covenants, as these are particularly sacred to the Zoroastrian. He takes part also in battles, for the Zoroastrian Law desires from its adherents an unswerving adhesion to its doctrine[5]. He is lastly called *tanu-māthra*[6], 'he whose body is the Holy Word,' because in him obedience towards the precepts of that Word and their fulfilment appear to be embodied.

Thus we have succeeded in deriving from one fundamental idea, which can be recognized in the very meaning

[1] Vend. XVIII, 16.

[2] Vend. XIX, 41 [*Sraoshô · ashyô · kundem · bangem · vībaṇgem · ava-janyāt*]

[3] Ys. LVII, 8, 2 and 24 [*Yô (sraoshô) daenô-disô · daenayāô. Yô · paoiryô · gāthāo · frasrāvayat · mat-āzaiṇtīsh · mat-paiti-frasāo*].

[4] Ys. LVII, 22.

[5] Ys. LVII, 10; Yt. XI, 14; Ys. LVII, 12.

[6] Vd. XVIII, 14.

of the name, all the powers of Srausha and all the notions which cluster round that *yazata* in the Avesta. Something similar is, perhaps, also possible with regard to the female *yazata* ASHI, or, more fully, ASHI-VAǦHVI.

Ashi is 'Piety,' in the broad sense which the Mazdayasnãn give to that idea—'the moral order.' Hence she is called, in an allegorical manner, the daughter of Ahura and of Spentā Ārmati, the Humble Devotion, and the sister of Srausha, Rashnu, Mithra, and of the Mazdayasnãn Religion[1]. She is most closely and intimately coupled with all the virtues which mark the Zoroastrian.

As the protectress of the moral order, Ashi bestows the human intellect, by which we must probably understand the faculty of distinguishing between good and evil[2]. She is, further, the defender of matrimony. She abhors courtesans and adulteresses, who violate this institute of the moral order. She hates those who keep a maiden by force from marriage, and thus withhold her from her destination[3]. In general she displays her activity chiefly in the house, probably because the entire moral order rests upon the narrow circle of the family. She is therefore invited into one's own house:

'*Ashi · srîra · dāmi-dāite · mā · avi · asmanem · frashûsa · mā · avi · zãm · niurvaese · itha · me · tûm · hãmcharaǧuha · antare · aredhem · nmānahe · srīrahe · khshathrô-keretahe*[4].

'Beautiful Ashi, created by the Creator, go not up into heaven, nor down to the earth; come thou to me into the interior of my house, of the fine, lordly one.'

The blessings which Ashi bestows are very multifarious.

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[1] Yt. XVII, 16; XVII, 2 [(*dughdharem · Ahurahe · Mazdāo*). (16) *Pita · te · yô · Ahuro · Mazdāo* . . . *māta · ārmaitish · spenta · brāta · te · yô · sraoshô · ashyô · rashnushcha · mithrascha* . . . *qaǧha · daena · māzdayasnish*.]

[2] Yt. XVII, 2 [*Yā · (ashi) frasha · khrathwa · frāthanjayeiti · uta · āsnem-khratûm · ava-baraiti*.]

[3] Yt. XVII, 57–59.

[4] Yt. XVII, 60.

She confers power and riches, gold and silver, garments and shining rings, and to maidens she grants the beauty with which they please their husbands[1]. She was in close friendship with Zarathushtra as the founder of piety, but now too she presents herself to him who invokes her to unite herself with him[2].

By way of appendix we shall discuss in this section a genius that occupies a separate position and cannot be included in any of the groups treated of hitherto. It is GEUSH-URVAN, 'the Soul of the Bull,' also called DRUVĀSPA.

We have under the name Geush-urvan undoubtedly an embodiment or concentration of the welfare and prosperity of herds. She is their representative, who has to defend their interests.

Just as in the oldest periods of Zoroastrian civilization the occupations of agriculture and cattle-breeding played a very important part, so is it easy to understand why Geush-urvan occurs already in the Gāthās. Here a song[3] is found, in which the 'Soul of the Bull' complains before the Deity of all the oppressions and dangers which are inflicted upon her by enemies, evidently the plundering nomads. Ahura predicts to her the future mission of Zarathushtra, who will indeed not merely be the founder of a new religion, but who will also confer upon men at the same time the blessings of civilization, imposing upon them as a duty a settled life, the cultivation of the field, and the careful rearing of cattle.

So also in the later Avesta, Druvāspa is the protectress of herds, though we do not learn any particulars regarding her. Her work is described in a general way at the beginning of the Yasht dedicated to her, where it is said:

> *Druvāspem · yazamaidę · druvō-pasvãm · druvô-staorãm · druvô-urvathãm · druvô-aperenāyukãm · pouru-spakhsh*h*tīm · dûrāt-pathana · qāthravana · dareghô-hakhedrayana · yukhta-aspãm · varetô-rathãm ·*

[1] Yt. XVII, 6.
[2] Yt. XVII, 1, 21; Yt. XIII, 107.
[3] Ys. XXIX.

*qanat-chakhrãm · fshaonîm · marezãm · amavaitîm · huraodhãm · qãsaokãm · baeshazyãm · druvô-stãitîm · druvô-varetãm · avaghẽ · narãm · ashaonãm*[1].

'Druvâspa we praise, who keeps small cattle and large cattle, friends and children in vigour; who grants ample protection, appearing from afar, dispensing good-luck, long-continuing friendship; who yokes her steeds, makes her chariot roll, the wheels to rattle, granting nourishment, purifying, strong, well-shaped; who grants good profits; who renders powerful support; who possesses rich treasures for the assistance of the pious people.'

## VI. MITHRA.

MITHRA is no doubt one of the most interesting genii of the Zoroastrian. In him are combined, as in no other figure of the Avesta religion, old and new, Arian and especially Irãnian, symbolical parts of nature and ethical constituents. But Mithra is also at the same time a manifest instance of the manner in which, in the Avesta, the deities originating from a pre-Zoroastrian epoch are usually conceived and transformed according to the new spirit. Hence it would appear proper to devote a particular section to Mithra.

The great number of hymns which are united in the Mithra-Yasht, may of themselves prove the important place which the veneration of Mithra held in the nation. He was perhaps one of the most popular *yazatas*; and just for that reason, I believe, he had in the system itself to rank after the purely ethical genii and abstract ideas, as for example the Amesha Spenta.

Mithra has his physical and his moral sides. The latter is founded on the former, and proceeds from it. The two should be strictly distinguished.

Physically, Mithra is the *yazata* of the rising sun, or,

[1] Yt. IX, 1, 2.

more accurately, probably the *yazata* of the light radiating from the sun.

> *Mithrem · yazamaidẹ . . . yô · paoiryô · mainyavô · yazatô · tarô · harãm · āsnaoiti · paurva-naẹmāt · ameshahe · hû · yat · aurvat-aspahe · yô · paoiryô · zaranyô-pīsô · srīrāo · bareshnava · gerewnāiti · adhāt · vīspem · ādidhāiti · airyô-shayanem · sevishtô*[1].

> 'We praise Mithra, who, as the first heavenly *yazata*, rises above the Hara, before the immortal sun, the swift-horse; who first, gold-modelled, surrounds the beautiful mountain-summits and then looks over the entire land of the Arians, the helpful.'

The description of sunrise, which forms the basis of these lines, may be still clearly perceived. On the *Hara barzati*, the mountain over which the sun rises, Ahura Mazda has erected for Mithra a dwelling. Yonder there is neither night nor darkness, neither cold nor heat, neither sickness nor grief, and no fog ascends from the mountain[2].

As the *yazata* of sun and light, Mithra is called *vouru-gaoyaoiti* 'the lord over wide fields[3].' He is also named *daǧhu-paiti* 'the prince of the countries[4].' For the sun is the king of the heavens, and he looks at the same time over all the dominions of the earth.

The light is the symbol of truth. Hence the sun is called the eye of Ahura, because with it he surveys the whole world and perceives everything right and wrong. When once such ideas exist, it cannot surprise us that also Mithra, the *yazata* of the sun-light, should himself become a guardian of truth and justice. If we look more closely into the entire character of the Avesta religion, we shall find it intelligible that this ethical part of the nature of Mithra occupies a far wider space than his physical importance.

[1] Yt. X, 13; comp. also Yt. X, 95.

[2] Yt. X, 50.

[3] Yt. X, 1, 7, 10, 12, &c.

[4] Yt. X, 78 [*mithrô · raẹvô · daǧhu-paitish*; Yt. X, 145, *mithrem · vīspanãm · daqyunãm · daǧhu-paitīm · yazamaidẹ*].

Mithra is the guardian of truth, the *yazata* of oaths and promises. As such Mithra is *adhaoyamna* 'the infallible,' and 'the undeceived one[1].' In an allegorical manner this is expressly indicated by the Avesta, when it says: 'he has a thousand ears (*hazagrô-gaoshem*[2]) and ten thousand eyes (*baevare-chashmanem*)[3].' He neither rests nor sleeps, he hears and sees everything that happens[4]. His scouts are posted on high watch-towers and announce to him what passes on the earth[5].

As is usually the case with the deities of the sun in the Arian religions, so also in the Avesta is Mithra described as a warlike courageous youth who drives in a chariot through the spaces of the heavens:

> *Ahmya · vāshe vazāonte · chathwārô · aurvañtô · spaetita · hama-gaonāoghô · mainyu*sh*-qaretha · anaoshāoghô*[6].

> 'Four horses draw his chariot, white ones, of the same colour, which eat the heavenly food, (and are) immortal.'

In this chariot Mithra drives into the battle, in order to support his adherents and to annihilate the 'betrayers of Mithra' (*mithrô-druj*), by whom we must probably understand the enemies of the Zoroastrians in general:

> *Āat · yat · mithrô · fravazaiti · avi · haenayāo · khravīshyeitī*sh *· avi · hām-yanta · rasmaoyô · antare · daghupāperetānę · athra · narām · mithrô-drujām · apā*sh *· gavô · darezayeiti · pairi · daema · vārayeiti · apa · gaosha · gaoshayeiti*[7].

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[1] Yt. X, 24 and often.

[2] Yt. X, 1, 7, 10, 12, &c.; Ys. I, 3; II, 3.

[3] Yt. X, 1, 7, 10, 12, &c.; Ys. I, 3; II, 3.

[4] Yt. X, 102, 103 [*mithrem · aqafnem · jaghāurvāoghem . . . yô (mithrô) anavaghabdemnô · zaęnagha · nipāiti · Mazdāo · dāmān · yô · anavaghabdemnô · zaęnagha · ni*sh*haurvaiti · Mazdāo · dāmān*].

[5] Yt. X, 45, 46. It should also be remarked that *Mithra* in the Yasna and the Vendidad simply means 'covenant, promise.'

[6] Yt. X, 125.

[7] Yt. X, 48.

'When Mithra thither drives against the terrible hostile armies, against those thus gathered together for fight, in the battle of the countries, then he binds the arms of the *betrayers of Mithra* to their backs, then he blinds their sight, and deafens their ears'

This idea being amplified, Mithra becomes in general a *yazata* of war:

*Vazrem · zastaya . drazhemnô · satafshtānem · satô-dārem · fravaeghem · vīrô-nyāonchem · zarôish · ayaghô · frahikhtem · amavatô · zaranyęhe · amavastemem · zaenām · verethravastemem · zaenām*[1].

'He bears a club in his hand, with a hundred knobs, and a hundred edges, that sweeps downwards, crushing men, cast out of yellow brass, out of solid, gold-coloured (brass), which is the most powerful and most victorious of weapons.'

With his club he slays his opponents, the men and horses together[2]. He is, therefore, invoked by warriors both for strength for their teams and health for their bodies[3].

## VII. DEMONOLOGY.

The question how evil, sin and guilt, grief and misfortune, come into this world has engaged Philosophy in all ages. For Zoroastrianism it was particularly important, since that system does not attribute to the divine beings any of the human passions and faults, but only recognizes in them pure, holy, absolutely good existences.

The Zoroastrian doctrine has accordingly solved that question by maintaining from the beginning a dualism of forces, one good and beneficent, and another evil and destructive. The former is essentially represented by SPENTO MANYU; the latter by his opponent ANGRA MANYU. As Ahura has a group of archangels and angels near Him, who support Him in His work, so is Angra Manyu surrounded by a body of evil spirits and demons.

On account of this opposition of good and evil, Zoroas-

[1] Yt. X, 96. [2] Yt. X, 101. [3] Yt. X, 94.

trianism has been often called a dualistic religion; but the title cannot be considered correct [1]. It is true the evil power co-exists from the beginning with the good one, but as I have explained more distinctly in the chapter on the 'Eschatology' of the Avesta [2], it will be overthrown in the great decisive combat at the end of the world, and will be annihilated.

The highest amongst the evil spirits, the prince of the demons, is Angra Manyu 'the evil pernicious spirit.' That he existed along with Ahura Mazda (or Spento Manyu 'the blissful spirit') from the beginning, is expressed clearly enough in the Gāthās. The former rules over evil, and the evil-minded ones collect around him; the latter is the Father and Creator of everything good. He is worshipped and followed by the pious and faithful.

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[1] [Cf Haug, *Essays*, p 303: 'The opinion, so generally entertained now, that Zarathushtra preached a Dualism, that is to say, the idea of two original independent spirits, one good and the other bad, utterly distinct from each other, and one counteracting the creation of the other, is owing to a confusion of his philosophy with his theology. Having arrived at the grand idea of the unity and indivisibility of the Supreme Being, he undertook to solve the great problem which has engaged the attention of so many wise men of antiquity, and even of modern times, viz how are the imperfections discoverable in the world, the various kinds of evils, wickedness and baseness, compatible with the goodness, holiness, and justice of God? This great thinker of remote antiquity solved this difficult question *philosophically* by the supposition of two primeval causes, which, though different, were united, and produced the world of material things, as well as that of the spirit; which doctrine may best be learned from Ys. XXX (*vide* pp. 149–151).'

Cf. also West, *Pahlavi Texts*, Part II, Introduction, p xxiv. 'The reader will search in vain for any confirmation of the foreign notion that Mazda-worship is decidedly more dualistic than Christianity is usually shown to be by orthodox writers, or for any allusion to the descent of the good and evil spirits from a personification of boundless time, as asserted by strangers to the faith. No attempt is made to account for the origin of either spirit, but the temporary character of the power of the evil one, and of the punishment in hell, is distinctly asserted.' *Translator's note*

[2] *Vide* § 11, p. 111.

*At · tā · mainyû · paouruye · yā · yēmā · qafnā · asra-
vātem ·*
*Manahichā · vachahichā · shkyaothanôi · hî · vahyô ·
akemchā ·*
*Âoschā · hudāoghô · eresh · vīshyātā · nôit · dushdāoghô ·*
*At · chā · hyat · tā · hēm · mainyû · jasaetem · paourvīm ·
dazde ·*
*Gaemchā · ajyāitīmchā yathāchā · aghat · apemem ·
aghush ·*
*Achishtô · dregvatãm · at · ashaone · vahishtem · manô*[1].

'The two spirits who first of all existed, the twins
proclaimed to me of themselves.
The good and the bad in thoughts, words, and works,
And of those two the intelligent selected the right
one, but fools did not so.
When the two spirits came first together, in order
to create
Life and death, and (to order) how the world should
be at the end,
Then the most evil one appeared on the side of the
impious, but the best spirit appeared on that of
the pious.'

It is likewise clear that the doctrine respecting the powers co-existing from the beginning and standing diametrically opposed to one another, is expressed in the following passage:

*At · fravakhshyā · aghēush · mainyû · paouruye ·*
*Yayāo · spanyāo · uitī · mravat · yēm · agrēm ·*
*Nôit · nā · manāo · nôit · sēnghā · nôit · khratavô ·*
*Naedā · varanā · nôit · ukhdhā · naedā · shkyaothanā ·*
*Nôit · daenā · noit · urvānô · hachaintī*[2].

'Announce will I the two spirits at the beginning of
the world:
Of them spake the blissful also unto the destructive:

[1] Ys. XXX, 3, 4.
[2] Ys. XLV, 2; here the evil spirit is designated by the word *agrēm*.

"Neither our thoughts, nor our commands, nor our intelligence,
Nor our belief, nor our speeches, nor our deeds,
Nor our doctrines, nor our souls correspond."'

In all things Angra Manyu is the counterpart of Ahura Mazda (or Spento Manyu). The latter brings forth only what is good, the former only what is evil; the one creates life, the other death. Hence Angra Manyu is designated by the constant appellation *pouru-mahrka*[1], 'he who is entire death.'

Whoever causes goodness injures at the same time the evil spirit. No wonder then if Zarathushtra, who brought to men the true faith and the right piety, is regarded as the special opponent of Angra Manyu. With his birth the latter bursts out into the following cry of complaint and of rage.

*Zātô · be · yô · ashava · Zarathush*tr*ô · nmānahe · Pourusha*spahe* · kava · he · aoshô · vindāma · hāu · daevanãm · snathô · hāu · daevanãm · paityārô · hāu · drukh*sh-*vīdrukh*sh . *nyāonchô · daevayāzô*[2].

'Born, alas! is the holy Zarathushtra in the house of Porushaspa. How can we contrive his destruction? He is a blow against the *Daivas*, he withstands the *Daivas*, he is an opponent of the *Drujas*; the worshippers of the demons shall fall down headlong!'

As Ahura Mazda is surrounded by the Amesha Spenta and Yazatas, the great majority of the beneficent spirits, so is Angra Manyu by the demons. The kingdom of the former is the light, the kingdom of the latter is the night and darkness.

The demons are designated by the names of DAIVA and DRUJ. The former are male, the latter are female devils. Of the great body of the evil spirits, some appear more conspicuous, others less. On the whole, it may perhaps be said that in the Avesta the kingdom of evil is not quite so exactly and fully described as that of the celestial spirits.

[1] Pahlavi, *pūr-marg*. [2] Vd. XIX, 46.

It will therefore be necessary to say only a few words on this head. To the Amesha Spenta correspond a group of six demons, who in every respect, often even in very name, are opposed to the former, in the same way as their chief and prince himself is opposed to Ahura Mazda. They form the immediate associates, to some extent, the court of Angra Manyu. Against Vohu-manō there stands AKŌMANŌ, 'the evil mind,' against Asha-vahishta, ANDRA or INDRA, evidently an old nature-god, the Vedic Indra, who in the new religion was banished to the company of devils. The adversary of Khshathra-vairya is SARU, perhaps 'the tyrant,' as an enemy of Spentā Ārmati, NĀOĞHATYA is named, again a deity of nature of the pre-Zarathushtrian epoch. However, TAROMATI is also found, who is the type of 'arrogance.' To Harvatāt and Amertāt correspond TARU and ZARIJA, possibly 'hunger' and 'thirst[1].'

Among the rest of the Daivas, AISHMA, the demon of 'sudden anger,' should be particularly named. His destructive agency is indicated by the very epithet *khrvi-dru*[2], 'with a bloody weapon.' It is he who hurries men into rash and bloody deeds.

Along with him must be named ASTO-VIDHOTU, 'the crusher of the body.' He appears to be the demon who causes sudden and unforeseen death, availing himself for that purpose of the holy element of water and also of that of fire[3]. APAOSHA is the enemy of Tishtrya. He keeps back the rain and burns up, by the aridity and heat of summer, the vegetation of the earth. But he is defeated by Tishtrya after a hot combat, and now the refreshing and fertilizing rains pour down. Lastly, we may here notice BUSHYĀSTA, who seduces men in the morning to give themselves up to indolent sleep. His opponent is principally the vigorous Srausha and his faithful herald the domestic cock.

When we have briefly mentioned the PARIKAS and the

[1] Comp. Vd. X, 9.

[2] Yt. XIX, 95; Vd. X, 23.

[3] Vd. V, 8.

JAHIS, about whom I have had occasion to express myself frequently in my 'History of Civilization[1],' there remains only the terrible DRUJ NASUSH. She is the demon of decomposition. Immediately after death has taken place, she rushes in and takes possession of the body, which is thereby putrefied. Everything dead belongs to her and falls into her power, and whosoever therefore comes into contact with the dead has to submit to the ceremony of purification as prescribed by the Law.

It is hardly necessary for me to refer, in concluding this Introduction, to Spiegel's '*Eranische Alterthumskunde*,' in which the same subject has been treated The section on the 'Religion of the Old Iranians' is a rich mine of information concerning that subject. That my exposition nevertheless essentially differs from that of Spiegel, is owing to the special object which I had in view. It has not been my main purpose to treat the matter exhaustively; my chief aim was rather to render the characteristic elements of the Avesta religion conspicuous. I wished to show how it occupies an independent and highly important position, through its entire tenor and through the process of intuition which manifests itself in it. I wished chiefly to prove how the purely ethical element preponderates, while everything besides, especially the activity of the world of divine beings in the phenomena of nature, falls into the background.

Finally, may I hope that I have succeeded in sketching a clear and correct picture of the faith which Zarathushtra created thousands of years ago, and which is still professed up to this day by the Parsees of India and Persia!

WM. GEIGER.

NEUSTADT, a. d. H.
April, 1883.

[1] *Vide* § 16.

# CIVILIZATION

OF THE

# EASTERN IRĀNIANS

IN

# ANCIENT TIMES.

## CHAPTER I.

### ETHNOGRAPHY [1].

### § 1. *The Arians and their Extension.*

THE Avesta people, as we find them in the Sacred Texts, are pre-eminently a religious corporation. It is their attachment to the Mazdayasnian faith, or their hostile attitude towards it, which is the true criterion according to which all men are classified. To the priests, who composed these texts and whose ideas we may consider them to represent, the above was indeed the principal and cardinal question. He who did not accept the doctrine proclaimed by them, stood opposed to them as an enemy, as much perhaps as the members of foreign tribes with whom no relations were maintained. With the Irānians it was not the case, as it was with the Indians, that the whole nation adhered to *one* belief and *one* religion, prayed to the same deities, and offered sacrifice at the same altars. Nay more, the Irānian people were split up by the Zoroastrian Reform into two factions, which fought against each other with the greater enthusiasm, the closer had been the ties which had previously united them.

But whilst religion and religious unity appear in the fore-

[1] Geiger, *Ostīrānısche Kultur*, bk. i, ch. 3, § 23.

ground, the element of nationality is by no means insignificant. The Irānians did not regard themselves merely as members of the Mazdayasnān Community, who revered their God-sent prophet in Zarathushtra, and their highest God and Master in Ahura Mazda, but they also felt that they belonged to *one* tribe and *one* nation, they recognized the ties of blood derived from their ancestors, their common descent, language and customs, and they called themselves accordingly by one common name, that of 'Arian.' This name probably indicates the nation as that composed of the Noble, the True, and the Pious, for they believed every virtue and every desirable and praiseworthy quality to be the peculiar heritage of their own tribe, whilst they undervalued the character of foreign peoples in the same proportion as they exalted their own[1]. If, in accordance with another view, 'Arian,' like the German '*deutsch*,' denoted simply 'the man of one's own tribe,' the meaning of the name would in that case be essentially weakened[2]. Hence I adhere to the first explanation, which seems to correspond thoroughly with the spirit of the age and the self-conscious and exclusive character of the Irānians as also of the Vedic Indians.

As the legendary hero *Jāmāspa* beholds the army of the enemy advancing to battle, he implores the *female-yazata* Anāhita to bestow victory upon him as upon *all the other Arians*[3]. A man of the name of Erkhsha 'the Bear' is called the best archer *among the Arians*.

> 'Thee Tishtrya we praise, the bright, radiant one, who goest as swiftly along the sea Voru-kasha as the arrow obeying the will of Heaven, which Erkhsha

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[1] *Airya*=O P. *ariya* from root *ar*. The original signification is still often found in Skr. *arya*, 'true, devoted, and friendly to the gods' (Grassmann, *Worterbuch*, s. v.), as well as in the counterpart to *airya*: N. P. *anēr*, 'prava indoles' (Vullers, *Lexicon*, s. v). I must mention however that to the Av. *anairya* I give the meaning 'non-Arian' in all passages (also Vendidād I, 18)

[2] Roth, in the Petersburg *Sanskrit-Wörterbuch*, s. v. *arya*; Zimmer, *Altindisches Leben*, p. 100.

[3] Yasht V, 69: *Yatha·vispē·anyē·airē.*

has discharged who shootest swift arrows, who shootest the swiftest arrows amongst the Arians[1].'

The territories inhabited by the tribes of the Avesta people are spoken of as 'the Arian Lands' or as the 'Homestead of the Arians[2].' The consciousness of unity of race and of equality of blood displays itself most clearly in the statement that from *Gaya-maretan*, the first man according to Irānian belief (in the *Shāh-nāmeh* of Firdusi he is the first of the legendary kings under the name of Gayomard), Ahura Mazda created 'the race of all Arian regions, the seed of all Arian lands[3].' The Avesta itself, as we know, mentions *Aryana-vaija* (in which name that of the people is included) as the original seat and primitive home of the Irānians. With this name corresponds Strabo's 'Ariana,' which embraces the Eastern provinces, that is the primitive abode of the Irānian race, as well as the modern 'Irān,' which name is employed to the present day as the official designation of the whole kingdom of Persia. Herodotus also testifies to the antiquity of the name 'Arian.' He informs us that the Medes in earlier ages were universally named 'Arians[4],' a statement which may probably be taken in a somewhat wider sense than would appear from the author's own words to be intended; and the name may thus be applicable not merely to that single tribe, but generally to all the inhabitants of the Irānian highlands.

In the title 'Arian' is implied, according to our ideas, something distinguishing and honourable, a fact which explains its frequent occurrence in proper names. This might be adduced as a powerful argument in favour of the correctness of my own view; for if 'Arya' only meant 'fellow-countrymen,' it is difficult to believe that it would have been

[1] Yt. VIII, 6 and 37. I treat *Erkhsha* as a proper name = Ved. *ṛksha*, Rv. VIII, 68, 15. Cf. also Geldner and Noeldeke, *Zeitschrift der deutschen morgenländischen Gesellschaft*, vol. xxxv, p. 445.

[2] *Airyāo - daghāvō*, Yt. VIII, 9 and 56; X, 4, &c.; *airyō shayana*, Yt. X, 13.

[3] Yt. XIII, 87.

[4] Herodotus VII, 62.

found suitable for the formation of personal names. A whole series of such names as Ariobarzanes, Ariomardos, &c, is transmitted to us by Greek and Latin authors[1].

The Avesta nations are not actually styled 'Arians' in the oldest fragments of the Avesta, the Gāthās, but this absence may be explained from the character of the epoch of civilization represented by these hymns,—a period of the most embittered religious and economic struggles, in which the national element was entirely secondary. The reason cannot have been that the name was unknown; for it is primeval and older than the Irānian nation itself, which has received it from earlier ages. The Indians likewise speak of themselves in the songs of the Rig-veda as the 'Ârya[2],' and distinguish themselves as such from the dark-skinned aborigines of the land of the Indus and its five tributaries. During the contest with these—the enemy or *Dāsa*—the Arians, gradually advancing towards the East, occupy the plains of the Panjāb. It may be assumed, therefore, that even at the period when Indians and Irānians constituted a single undivided nation and when these two distinct tribes had not yet been formed, the name 'Arian' had been invented and was in use as a regular designation of the entire people. Furthermore, there are distinct traces extant which give it a still higher and more venerable antiquity. After the division of the Arian people had taken place, both the tribes, the Indian as well as the Irānian, retained their customary appellation and applied it in their usual manner.

It may not be without interest at this point to take a brief survey of the present distribution of the Arian race in the provinces of Central Asia, on the banks of the Oxus and the Jaxartes, as well as in Afghanistan. It is here

[1] Cf. Keiper, *Die Perser des Aeschylos*, p. 69.

[2] Ludwig, *Die Manthraliteratur und das alte Indien, als Einleitung zur Uebersetzung des Rig-veda* (Rv. vol. iii) 207; Zimmer, *AiL.* p. 100. In Indian the word *ārya* derived from the original form *arya* serves as a name of the people; however, cf. Böhtlingk and Roth, *Sanskrit-wörterbuch*, s. v. *arya*, as well as its compounds *aryajārā*, 'beloved of an Arian,' and *aryapatnī*, 'wife of an Arian.'

represented by that highly interesting class of people, the Tājiks, who have their abode in the midst of the Afghāns, Beluchees, and Uzbecks, as a tribe foreign to but tolerated by them and living in peaceful intercourse with them. They form the really settled part of the population living by commerce, industry, and agriculture, and are therefore very often called *dihkāns* 'peasants' or *dihvars* 'villagers.' Similarly in the Uzbeckian principalities the name *Sart* denotes the settled portion of the people, the inhabitants of towns and villages, as opposed to the nomadic Kirghis, while the Tājiks are understood to belong to the Arian race as opposed to the Turks or Tatars. Shaw on this point observes[1] 'Among these various tribes there are two great cross divisions. The first is the division of Turk and Tājik, or of Tartar and of Arian blood. The other classification is that of nomads and settled people, Kirghiz and Sarts.' Hence it follows that by nature, and in all their habits of life, as well as in the development of the civilization of particular tribes, the Sarts are mostly composed of Tājiks, while the nomads are invariably Tatars. Thus it is explained why the Sart and the Tājik are very often regarded as identical. But this is quite incorrect; 'for all the Khōkandis . . . agreed in affirming that Sart is merely a word used by the Kirghiz to denote all who do not lead a nomad existence like themselves, whether they be Tajiks or Uzbecks.' In a word, the name Sart has a purely historical import, while that of Tājik is rather ethnological.

[1] *Reise*, p. 21. Cf. Lerch (*Russische Revue*, vol. 1, 1872, p. 30, seq.), who derives the name Sart from O. Ir. *khshathra* (by metathesis *khsharta*=N. P. *shahar*, 'city') and examines the history of the expression with his usual thoroughness. Its most ancient application is said to have been in the name of the *'Ια-ξάρται*, whom Ptolemy mentions as living in the lowlands of the Sir (the Silis of the younger Pliny), where formerly more numerous towns, villages, and hamlets existed than at the present day. In Sogdiana the name Sart is obsolete, while it occurs again in Khiva. Sultān Baber denotes by it the populations of several towns and districts in Ferghānā.

Concerning the spread of the Tājiks in Afghānistan, I need not speak at length after what has been communicated to us regarding them by Elphinstone, and subsequently by Spiegel[1]. They are most numerous in the vicinity of the towns: they form the chief part of the population of Kābul, Kandahār, Herāt, and Balkh, while they are completely unknown amongst the inhabitants of the wilder portions of the land In several districts, especially in Kohistān, that is to say, not far from the capital of Afghānistān, they have preserved their independence. Here indeed they do not exhibit any trace of the submissive and cringing disposition which they so readily assume in their intercourse with a ruling caste. They are on the contrary warlike and eager for the fray, and live in constant feuds amongst themselves. Another branch of the Tājiks inhabits the Lōgar valley, and a third, that of the Furmūlis, is in possession of Urghun, to which we look for the old *Urva* of the Avesta. In Seistān, where they are called *dihkāns*, they likewise form the more ancient portion of the inhabitants collectively, and are similarly spread over the whole of Baloochistān, distinguished by their fixed mode of life and by the fact that they speak the Persian language.

In the country of the Amu and the Sir the Tājiks are far more important. Ujfalvy, to whom we are indebted for detailed and authentic historical accounts of them, correctly points out that three classes must be distinguished: firstly, the native Irānians, who naturally claim our fullest consideration; next, the Persian colonists; and, lastly, the descendants of Persian slaves[2]. The indigenous Tājiks as a general rule have brown hair and beards, but there are also found individuals with fair or red hair. Khanikoff[3] describes them as tall people with black hair and beards. Their eyes are large and dark, the nose well formed, the

[1] Spiegel, *Eranische Alterthumskunde*, vol. i, p. 340 seq.

[2] Ujfalvy, *Expéd. scient.* vol. ii, pp. 33–34; Khanikoff, *Mémoire sur l'ethnographie de la Perse*, p. 92.

[3] *Mém. sur l'ethnogr.*, p. 103; comp. Spiegel, *E. A.* vol. i, pp. 339–340.

mouth rather large, the forehead broader, and the whole structure of the body somewhat heavier than in the case of the Western Persians. Shaw[1], to whom we are indebted for most of our knowledge respecting the inhabitants of the Pāmir, describes the Tājiks as follows —

'The Tajiks are a very handsome race with high foreheads, full expressive eyes shaded by dark eyelashes, thin delicately-formed noses, short upper lips, and rosy complexions Their beards are generally very large and full, and often of a brown and even sometimes of a reddish tinge. They differ from the high-caste men of Northern India only, in being more stoutly and strongly built, and in having fuller faces.

'Their kinsmen, the men of Badakhshan, bear even a closer resemblance to the Northern Indians. . . . The Wākhanis partake of these characteristics, having also some of them light hazel-coloured eyes, as have also the Sirikulis whom I saw at Kâshghar. But the rough life they lead in their highland valleys has given them a certain harshness of feature as well as an asperity of character, which contrasts with the good temper of their neighbours, the Kirghiz.'

Ujfalvy further points out that 'the Tājiks of the mountains' are of a more independent and noble character than the inhabitants of the plains This, as well as their exterior and the primitive customs which are preserved amongst them, permits us to recognize in them the genuine descendants of the old Mazdayasnān. As everywhere else, so also in Central Asia, the secluded and inaccessible character of the high mountainous districts helped to preserve and perpetuate the peculiar characteristics of their inhabitants.

The Tājiks of the mountains are collectively called by the name of Galcha[2]. I do not think we can with justice

[1] *Reise*, pp. 22–23.

[2] The name probably means 'mountaineer,' if the derivation of Tomaschek (*Pamirdialekte*) from Pers. *ghar*, O. Ir. *gairi*, is correct. Ujfalvy: 'le Gálca qu'on a appelé jusqu'à présent aussi Tadjik des

accept any fundamental distinction between the Galchas and the Tājiks of the plains[1]. All the differences that exist between them, whether extrinsic or intrinsic, may be explained by the fact that the former, being isolated in their mountains and high valleys, preserve the type of the Arian race in a purer and less impaired state, while the latter, through their intermixture with Tatarian elements, have lost much of the purity of their blood.

The Galchas are described as individually handsome, with brown, and occasionally red or even light flaxen hair; while the *brachycephalous* skull-formation and considerable skull-capacity form a striking peculiarity, which but seldom appears prominently in the pure Tājiks[2]. Galchas are found in the valleys of the mountains surrounding Ferghāna; they dwell in the country round the sources of the Zerafshān, particularly in the valley of Yaghnōb and along the Oxus as far up as its sources in the Pāmir; and even in the eastern parts of the plateau of Pāmir itself, that is to say, beyond the Neza-tash ridge, we meet with them in the district of Siri-kul Not less interesting are the natives of the southern declivity of the Hindūkush, in Chitrāl and Kafiristān, but they appear to belong mostly to the Indian race.

The language of the Galchas, which has been of late the object of careful investigation[3], is divided into several dialects, which have a particularly close connection with

montagnes' ('the Galca who was called also up to now the Tajik of the mountains').

[1] Cf. Van den Gheyn in the *Bulletin de l'Athéné Oriental*, 1881, pp. 221–223.

[2] Tomaschek, *Pamirdialekte*, p. 5 seq

[3] Tomaschek, in his *Zentralasiatische Studien*, vol. ii, has worked up the materials collected by Shaw ('On the Ghaltcha Languages,' 'Journal of the Asiatic Society of Bengal,' vol. xlv, 1876, pp. 139–278; xlvi, 1877, pp. 97–126). He holds the inhabitants of the Pāmir to be the descendants of the Saks, and 'such a linguistic research is to serve above all as a valid support to the following historical proof that these Saks were a purely Irānian tribe, which had preserved the old Irānian mode of life and the genuine Irānian type in greater

the old Eastern Irānian, and thus with the language of the Avesta. If it shows an admixture of Indian words the reason for this probably lies only in their primitive condition, in consequence of which they still suggest to us more of an original affinity with the Indian than with Modern Persian.

Of the Pāmir dialects the Mungī or Mindshāni is the most important. It is spoken in Mungān, the neighbourhood of Karān, Paryān, Shangān, and in the still unknown valleys on the frontiers of Kāfiristān, and is distinguished by a peculiar resemblance to the Avesta language. In the valley of the Panja, according to the different districts. the Wākhi, the Ishkāshamī, and Shigni are spoken. Besides this, the Sanglichī, the dialect of Sanglich (between Mungān and Ishkāshim), is worthy of mention, as well as the Yaghnōbī, the language of the Galchas in the mountains near the upper Zerafshān. I must not pass over the report of Mushketoff[1] upon the Galchas dwelling in the vicinity of the glaciers of Zerafshān. He regards them as the direct descendants of the ancient Persians. Their civilization is a highly primitive one. They do not occupy themselves with agriculture; their houses and chattels are made of stone, the former without lime or cement. Their sole domestic animal is the *Ishak*, a kind of wild ass, which they use for carrying burdens.

We have just spoken of members of the Irānian stock, who have remained in a very low stage of civilization. Of the other Galchas this cannot be asserted in the same degree. I incline to believe that we may recognize in them the descendants of the Zoroastrians. The Avesta expressly described the primitive home of the Irānian people, the most holy *Aryana-vaija*, as being situated in the mountainous countries drained by the Sir, the Zerafshān, and the Amu. Into these almost inaccessible valleys the faithful adherents

purity than the Medo-Persians, who were strongly influenced in every way by the Semites.'

[1] 'Proceedings of the Royal Geographical Society,' vol. ii, 1880, pp. 765–766.

of the Mazda religion may have retired further and further before the attacks of the Tatars and the Arabs. There they still cherished for a long time the ancient and venerable *cultus* which they had inherited from their ancestors. Many antiquated customs, preserved to the present day, point to this conclusion. For instance, Wood[1] relates that he observed among the inhabitants of Badakhshān and Wakhān a peculiar disinclination to blow out a light. This is in conformity with the ideas and usages of the Zoroastrians, and, more important still, of the Zoroastrians alone. Fire was notoriously regarded by them as the most sacred element, which must be preserved as much as possible from any kind of profanation. Even the breath of man or his spittle is sufficient to desecrate it. Therefore even the priest before the fire-altar must perform his ceremonies and recite his prayers with his mouth covered. I can allude but briefly to the peculiar customs of the Kāfirs: their practice of exposing the dead, and also their peculiar treatment of women after delivery and during their courses, which correspond so closely to the similar precepts of the Avesta that we can scarcely admit the possibility of a merely accidental resemblance[2].

Finally, our theory is corroborated by native legends. In Shignān a tradition[3] exists that the inhabitants of that land were, so late as from 500 to 700 years ago, *Zardushti*, adherents of the Mazda religion, and that only then were they converted to Islām by Mahomedan emissaries from the neighbouring western provinces. Certain buildings in the valley of the Oxus are dedicated to the *Âtashparastagān*, or 'fire-worshippers[4].' Even if this statement be not altogether accurate, it still proves that people have preserved in the Galcha provinces down to the present day the remem-

[1] 'Journey,' pp. 177, 218; comp. therewith Spiegel, *E. A.* vol. i, p. 339.

[2] Masson, 'Narrative of Various Journeys in Baloochistān, Afghānistān, and the Panjāb,' vol. i, p. 224 seq.; Spiegel, *E. A.* vol. i. p. 397.

[3] Gordon, 'Pāmir,' p. 141.

[4] Wood, 'Journey,' p. 218.

brance of their former connection with the old national religion

If at a future time the veil which still hangs over the territories of the Oxus viz. Shignān, Roshān, and Darwaz, should be lifted by a courageous traveller and inquirer, we may expect to receive new and abundant information concerning the highly important questions of Central Asiatic Ethnography and Irānian Antiquity

## § 2. *The Adversaries of the Avesta People.*

THE life of the Avesta people was by no means one of peacefulness and tranquillity. The Gāthās themselves present a picture of continual combats and feuds, and show us how the existence of the newly-founded community of the Mazdayasnān remained for a long time most precarious and uncertain. By degrees, however, all opposition seems to have broken down, the Mazda religion throve and increased, the number of its adherents grew larger from year to year, and in the more recent part of the Avesta they appear no longer as a maligned and persecuted people, but as victors and rulers.

This brings us to a cardinal question in the history of the civilization of the Avesta people, a question which we may briefly state as follows Are we to concede that the Irānians, at the time of their immigration into the settlements described in the Avesta, did not there meet with an aboriginal people not akin to them? Do we learn from the Avesta itself anything of conflict with tribes of non-Arian race? Or do all the descriptions of hostile surprises and warlike undertakings, which occur in the Avesta, refer solely to the feuds carried on amongst the Irānians themselves; and are consequently the names of nations (to be hereafter enumerated) handed down to us in the Avesta to be all explained as designations of particular tribes (and their subdivisions) of the Irānian people?

As regards the first part of this question, it is evident that in the Avesta a very marked social and religious

opposition is exhibited from the beginning, a contrast between the settled population and the nomads, between the adherents of the Zoroastrian doctrine and their enemies. And from that time forward it is unquestionable that this opposition is of paramount importance, and is most strongly emphasized by the authors of the Avesta. However, I believe that all the circumstances bearing on this point have not yet been explained. As the inhabitants of Turkistān are divided according to descent into Turks and Tājiks, into members of the Arian and Tatarian races, and according to occupation into Sarts and Kirghiz; so, side by side with the economic separation of the population into wandering herdsmen and agricultural settlers, there exists also a national schism which affords us proof of the existence of a non-Arian element in old Irān. It is true, the national opposition, so far as it seems to be indicated in the Avesta, does not belong to the present, but rather to the past—at least more frequent mention is made of the battles fought with the race foreign and hostile to the Arians in the legendary stories than in the form of genuine historical narrative. However, all this none the less tends to prove the existence of a non-Arian aboriginal people.

The religious and economical schisms more or less coincide, as we shall see presently. The Zoroastrian doctrine thrives among the settled population, who first accept it, while the nomadic tribes mostly decline to submit to its binding and restraining laws. The Avesta on this account invariably extols the settled life of the peasant and the careful tending of cattle, and recognizes a religious merit in the cultivation of the soil and in the reclaiming of land still lying waste, as also in the gradual promotion of civilization.

But the social contrast can be as little mistaken for the national one in old Irān, as it can in the present age in the principalities near the Sir and the Amu. It is probable, from internal evidence, that the non-Arians were mostly nomads; but there is no doubt that a considerable part of the old Irānian nation also followed the same roving

manner of life. They had as yet by no means universally taken to agriculture and permanent settlements.

I begin with the Gāthās, the only part of the Avesta the contents of which are exclusively devoted to contemporary events and the description of existing circumstances Here the contrast is manifestly the economic and religious one. I shall refer to this more in detail, when, in the economic portion of my work, I have to speak of the mutual relations of agriculture and cattle-breeding, as well as of the contrast between the nomadic and the settled populations.

On the one side stand the husbandmen, the pious, the faithful, truly devoted to Ahura Mazda and the Good Doctrine, who distinguish themselves particularly by the care which they bestow upon the sacred cow. On the other side we behold the impious, who do not plough the field, and who cause injury and harm to the cow: these are the nomads, who have no knowledge of the systematic rearing of cattle, the unbelievers who do not accept Zarathushtra's doctrine. That these too were Irānians is proved by the mere fact that the prophet argues with them, propounds his doctrine to them, and calls upon them to decide in its favour. This at least presupposes a community of language and a certain measure of relationship which we could not admit as existing between Arians and non-Arians. We have only to remember the sublime passage in which Zarathushtra, or one of his first adherents and followers, preaches the new faith (evidently in the midst of a large gathering of peasants), beginning with the words—

'I will announce it: Now hear and understand,
Ye who have come from near and from far[1]!'

Between the believers and the unbelievers, the husbandmen and the nomads, bloody conflicts ensued:

'He shall not disturb our prayers,
Who said how one beholds in the worst manner (*or profanely*)

[1] Yasna XLV, 1.

The cow and the sun with one's eyes;
Who bestows gifts upon the wicked,
But causes the pasture-grounds to lie waste,
And hurls his weapons against the pious[1]!'

The prophet even summons his adherents openly to the fight:

'None of you shall listen to the words
And precepts of the wicked,
For into his house and into his village,
Into his estate and his country
Will he bring grief and death.
Therefore slay them with weapons[2]!'

The separation of the people into believers and unbelievers begins in the Gāthās, and continues throughout the whole of the Avesta. It is highly characteristic of the tone of the Avesta, and the language possesses a complete series of expressions whereby the adherents of the Zoroastrian religion and their opponents are designated[3]. From the wicked, who are ignominiously compared even with noxious and loathsome animals[4], originated every kind of evil, viz. hatred, enmity, and discord[5]; the faithful, on the contrary, distinguish themselves by their pious and holy spirit and their humble devotion towards Ahura Mazda[6].

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1 Ys. XXXII, 10.

2 Ys. XXXI, 18.

3 The most important amongst them are: *Asha* or *ashavan* (Skr. *ṛtâvan*), 'pious, righteous;' *anashavan*, *drvat* (in the Gāthā-dialect *dregvat*, where *g* strengthens *v*, as in *hvōgva*, identical with *hvōva* of the common dialect), 'impious, unrighteous;' *hudaena*, 'adhering to the good doctrine;' *duzhdaęna*; *Mazdayasna* 'Mazda-worshipper;' *daęvayasna*, 'demon-worshipper;' *dahma*, 'pious;' *adahma*. Fellow-believers are called *hāmō-daęna* or *hva-daęna*, the believers in other faiths *anyō-varena* or *anyō-tkaęsha*.

4 Hence *khrafstra-mashya*, 'men like *khrafstras*.'

5 *Aęnağh*, 'hatred,' proceeds from the wicked (Ys. XXXII, 6–8); the wicked are designated as *tbishvañtō*, 'malignant, hostile' (Ys. XXVIII, 7); their resistance is called *paiti-rema*, *aęshma* (Ys. XLIV, 20; XLVIII, 7; XLIX, 4, &c.)

6 Hence the abstract terms *asha*, *vohu-manō*, as well as *ārmaiti*

The constantly recurring prayers of the Avesta. therefore, are especially those which call down blessings and happiness upon the faithful, and misery and misfortune upon the wicked.

> 'According to desire, power over all good that originates from piety is given to the pious; but no power is given to the wicked! Master of his wishes be the pious, impotent in his wishes be the wicked! Joy and prosperity do I wish for the world of the pious, but distress and adversity do I wish for the entire world of the wicked[1].'

The religious and the economic schism in the population of old Irān is thus beyond question illustrated clearly enough. It is undoubtedly far more difficult to prove the existence of a race-opposition between the Arians and the non-Arians.

The plains near the Caspian and Aral Seas, as also those along the northern shores of the Black Sea, were, even in the most ancient days, inhabited by a large number of wandering tribes, which are usually classed under the general appellation of 'Scythians' by the Greeks. They may be considered as consisting chiefly of the aboriginal population of Irān. If they were of Tatarian descent, like the present inhabitants of the steppes—and certain analogies in their mode of life and customs with those of the present Turkomans and Kirghiz cannot but be recognized—the diversity of race would be thereby established. However, it is almost agreed that the Scythians were of Arian descent, as appears particularly from the proper names transmitted to us through the medium of Greek writers. The southern tribes appear to have belonged to the Irānian, the northern perhaps to the Sclavonic branch of the Indo-Germanic family[2]. Concerning

(in the Gāthās=āramaiti), are frequently used as concrete for 'the pious, righteous;' Ys. XXXIII, 3; XXXIV, 2 and 3; XLVI, 16, &c.

[1] Ys VIII, 5, 6, 8.

[2] Duncker, *Geschichte des Alterthums*, vol. ii, p. 430 seq.; Spiegel, *E.A.* vol. ii, p. 333 seq.

the Scythian nation of the Saks, which dwelt in the mountainous countries near the upper banks of the Amu-daryā, Tomaschek[1] specially undertakes to adduce proofs that it was a genuine Irānian tribe, and that it has preserved the characteristics of the Irānian nation in a purer and more genuine form than perhaps the Persians or the Medes. Here again then we have no national contrast, but merely another instance of that economical separation of the Irānian people into nomads and settled colonists, which is indicated by the most ancient fragments of the Avesta. The Scythians represented only those tribes which still wandered over the steppes as migratory herdsmen; whilst the Sogdians, Persians, Medes, Bactrians, Arians were those who had taken to the cultivation of the soil and to permanent dwellings. But if the Scythians of ancient times exhibit many striking points of resemblance in customs and ways of life to the modern Tatarian inhabitants of the steppes; if they, like the latter, distinguished themselves as bold riders, delighted in continual battles and feuds, drank mares' milk as their favourite beverage, and lived in the most astonishing and repulsive uncleanliness,—all this must have been on account of the identity of external circumstances in the nature of the soil and climate, whereby both have been influenced, and the same results were brought about at different times and among different nations.

I do not wish to deny the Irānian, or at all events Arian, nationality of a large portion of the Scythian tribes, least of all that of the Saks[2], but I would remark that the name 'Scythian' is used rather vaguely by Greek writers. It strikes me that the name had more of an economic import, and comprehended all the nomadic nations of the Eastern

[1] *Pamirdialekte*, p. 4.

[2] According to Grigorjeff ('On the Scythian Tribe of the Saks'), as well as according to Cuno ('Inquiries in the Region of Ancient Ethnography, part i, 'The Scyths'), the Saks are a Sclavonic people; while in other quarters this view is disputed (cf. *Russische Revue*, vol. i, pp. 103–105).

European and the Central Asiatic lowlands, without taking into consideration whether any differences of blood and language existed. In short, the notion contained in the name 'Scythians' is co-extensive with the vague and general expression 'Tūrānians,' much in favour with modern writers, or perhaps with the term 'Kirghiz' in the case of modern Turkistān. If, therefore, it can be proved with certainty of a part of the Scythians, that they belonged to the Arian race and spoke an Arian language, it does not follow that there were not also tribes of a foreign race, perhaps Tatars, amongst the Scythians and reckoned as belonging to them[1].

This is merely by the way. As we are here dealing only with a possibility, I shall omit further mention of the Scythians, and shall attempt to discover whether no other traces of a non-Arian aboriginal population may be discovered. And such traces are undoubtedly to be found. The best Assyriologists are agreed that the Semites, on their immigration into the plains of the Euphrates and the Tigris, found a people foreign to them, with a culture, language, and writing of their own. From the blending of the two tribes, the Sumir and the Akkad, the aborigines and immigrating Kushites or Semites, arose the Chaldæan people. This gradual intermingling may have taken place only after fierce struggles and contests, but no tradition reaches back to those warlike ages of the past. Even in the oldest monuments we find Sumir and Akkad already forming one nation. The language of the Sumir became gradually extinct, and only survived as a sacred dialect still preserved in temples and schools. But the writing invented by the aborigines, viz. the cuneiform character, was now accepted as the predominant and only

[1] To my delight I here find myself in accord with Maspero, who asserts positively ('History of the Oriental Peoples in Antiquity,' p. 129): 'The Scyths, the oldest among mankind, belong at least partly to those tribes of the Tūrānian race, which even at the present day inhabit the north of Europe and Asia from the marshes of Finland to the banks of the Amur.'

current language of the Semites; it was adapted to the wants of the Kushite dialect, and served thenceforth for their writing, as it had done before for that of the Sumerian dialect. Every symbol now corresponded to a new sound, without however losing its old signification. The symbol which, in the Sumerian language, meant the sun and the day, still retained its Sumerian phonetic value in *ut*, *ud*, *par* and *para;* it may however be also read *shamash* or *yum*, which are the Semitic words for 'sun' and 'day.' Thus the writing of the Chaldæan cuneiform characters of itself reveals to us the striking intermixture of two dissimilar elements, pervading in a similar way the entire civilized life of the tribes of the Mesopotamian lowland[1].

It is therefore clear that we must assume the existence of an aboriginal population of foreign race before the appearance in the East of the Semites, and even before that of the Arians. That it did not confine itself to the districts round the Euphrates and the Tigris, but that it spread likewise over the entire plateau of Irān, is to be accepted as pretty certain. Whether that original population was a Tatarian one, cannot indeed be proved absolutely, but it is not improbable, if we consider the character of the Sumerian language. If, relying upon Chinese sources, we allow that the present Khānātes, Khiva, Bokhārā, and Khōkand, as well as Eastern Turkistān were inhabited in the most ancient times by an Arian population, and that the Mongol-Tatar race first occupied those districts in a comparatively recent period[2], I must declare myself altogether incompetent to decide this question. However, this does not seem to me to touch the root of the matter. If we speak of an aboriginal population of Western Asia, we are dealing with an epoch of time for which direct historical testimony cannot be demanded, and which indeed stands at the very dawn of history. If, then, the Tataric-Mongolian nations which

[1] Cf. Maspero, 'History,' pp. 135 seq., 152; Duncker, *Geschichte des Alterthums*, vol. i, p. 247 seq.; Spiegel, *E. A.* vol. i, p. 381 seq.

[2] Cf. *Russische Revue*, vol. ix, p. 328.

now possess Central Asia found Arian tribes there before them, very likely the Arians in their turn met in their first immigration with a primitive population of Tatars, which naturally, at the time when the new Mongolian invasion began, had been absorbed long ago by the ruling classes.

I would moreover suggest that no more weight be attached to these details than I myself allow them. For in order to attain to a really definite judgment on this difficult and complicated question, one must have made the most extensive studies regarding very different countries. Only the *possibility* that, side by side with the Arian population of old Irān, an older non-Arian one existed, may be considered as assured. This brings me to the principal point of my argument: How does the Avesta bear upon this question?

I shall later on adduce some indirect proofs, which seem to establish the existence of a primitive non-Arian race. That slavery existed in old Irān follows, as well as from other causes, from the fact that industry, in spite of the absence of a peculiar class of manufactures, had reached a degree of development by no means insignificant. The slaves may have been either captives taken in war from among the hostile Arian tribes, or, what is more probable, descendants of the conquered aborigines who had been deprived of their lands, but were allowed to follow trades which to the conquerors appeared less honourable than agriculture. We shall find further on that, in the houses of the Mazdayasnān, daughters of unbelieving tribes lived as maid-servants and concubines, a practice denounced in the Avesta with such abhorrence, that we may conclude therefrom that, like the *dāsa-women* of the Rigveda, these must have been women belonging to the non-Arian tribes, against whom the priests of Mazda preached with such holy indignation.

But in the Avesta we have also proofs of the most direct kind. *Non-Arians* are often expressly named, and, twist and turn them as we will, these facts cannot be ignored, and we are thus actually compelled to assume the existence of non-Arian tribes in old Irān. The non-Arian countries

are attacked by the Arians, they are destroyed through the glory of Zarathushtra[1]. This is a clear allusion to the war of races which the Irānians, especially the pre-Zoroastrian Irānians, waged with their enemies, and in which they proved victorious. Of the province of *Varna* it is expressly said that it contained non-Arian inhabitants[2]. Varna was, in my opinion, situated in the north-western parts of the country possessed by the Irānians, perhaps in the present district of Tāberistān. And it may be hence conjectured that the non-Arian tribes gradually withdrew before the victorious Arians into the almost inaccessible mountains of the Alburz, in order to maintain there, for at least some time longer, their ancient independence.

This non-Arian tribe in Varna I hold to be identical with the 'wicked people of Varna,' frequently mentioned elsewhere in the Avesta, who stand in close relation to the 'demons of Māzenderān[3].' As Māzenderān is not very distant from Tāberistān, there is good reason for believing

[1] Yt. XVIII, 2 (*anairyāo · dańhāvō*); Yt XIX, 68.

[2] Vd. I, 18; *anairyācha · dańhēu*sh · *aiwishitāra*. I read *aiwishitāra* instead of *aiwi*sh*tāra* according to the Vendidād-sāde and the Pahlavi translation. The latter has *anārīch matāān madam mānashnīh*. The word thus comes from the root *shi* = *kkshi*, and we need only be surprised that the root-vowel is not increased before the suffix *tar*.

[3] *Varenya · drvańtō* and *māzainya · daeva*. It has probably a similar sense, when it is said of *Urva* in the south-eastern boundaries of the territories of the Avesta people, that 'evil inhabitants' dwelt there (*agha · aiwishitāra*) Vd. I, 11; for its reading *vide* the preceding note; (Pehl. *sharītar avarmānashnīh*). Here we must probably think not of non-Arian but of Indian tribes. Very interesting also is the expression 'malignant or hostile tribes' (*dańhēu*sh · *rākhshāithyāo* and *rākhshyēitī*sh *dańhāvō*. Yt. X, 27 and 78, as *anairyāo · dańhāvō*). The epithet is derived from the rt *rakhsh* = Skr. *raksh*, and is thus akin to Skr. *rakshas*, which also serves in the Rigveda as a designation for hostile tribes. The meaning 'demon' which is usually found in dictionaries is certainly only the secondary one, as in the case of Dāsa and Dasyu. *Vide* Zimmer, *Altindisches Leben*, p. 109 seq.; Ludwig, *Einleitung zur Uebersetzung des Rigveda*, p. 211.

in the connection, and we are also entitled to recognize in the demons mentioned above only foreign aborigines, the remnants of whom maintained themselves longest in the swampy forests on the narrow coast-district between the Caspian Sea and Alburz.

The war of races is moreover assigned by the Avesta to a very ancient period. The tradition respecting that period of bloody warfare is attached to the half-mythical figure of *Haushyangha*—Hōsheng in Firdūsī—one of the oldest princes of the line of the heroic kings of the Avesta and of the Shāh-nāme:

> 'To the Ardvi-sura Anāhita did Haushyangha, the Paradhāta, sacrifice on the foot of the Hara, and he prayed to her: "Grant me this gift, O Ardvi-sura Anāhita, that I may become the supreme ruler over all demons and men, . . . and that I may slay two-thirds of the demons of Māzenderān and of the wicked people of Varna[1]."'

As we know, Strabo also makes mention of a tribe of the Anariaks, who according to him were settled on the coast of the Caspian Sea. Here we have the corrupt form of that name *Anarya* by which the Irānians of the Avesta could scarcely have meant merely an individual tribe dwelling near the Caspian Sea, but rather all the tribes that belonged to a race foreign to their own[2].

If my view is correct, the aborigines of the land are frequently designated as *daiva*, demons. They were to the orthodox Irānians only the earthly image of the superhuman, wicked powers. In an analogous manner the two ideas which indicate demons and foes belonging to foreign tribes are continually intermingled in the Rig-veda, and we cannot always easily distinguish, in the different passages, which of the two designations is the correct one. If in the

[1] Yt. V, 22.

[2] Strabo, pp. 507, 508 (here a city Anariaka is also mentioned), 514 near the Marders, the Hyrcanians, the Cadusians and similar tribes. The Ἀναριάκαι of Strabo would correspond closely enough to an Old Irānian *Anairyaka*, a derivative from *anairya*.

Avesta a distinction is made between daiva and men[1], we must naturally understand the former to mean superhuman monsters. It may be shown, however, that in the Rig-veda, too, the primitive population of the Panjāb, the people of the *Dāsa*, are frequently placed in direct opposition to the tribe of Manu, to the human race[2]. That the daivas of the Avesta may likewise be beings of flesh and blood we might be inclined to infer from the fact that even Mazdayasnān, when they grossly violate the commandments of Zarathushtra, degenerate into demons, and become like the rudest, most abject, and most profligate of men[3]. However, I may here assume a similar use to that of the German word *Teufel* (devil).

The struggle of the Arians with the daivas, the subjection of the primitive inhabitants of the Irānian highlands, naturally accompanied the first immigration of the Arian tribes in the earliest epoch of their history. Accordingly, the native legend assigns those events to the reign of King Yima, by whom also, as we shall see further on, the systematic breeding of cattle is said to have been introduced. His person at all events represents a very early and primitive stage of the civilization of the Irānian people. The Avesta makes him pray to Anāhita:

> 'Grant me that I may snatch away from the demons both wealth and plenty, both fields and herds, both nourishment and splendour[4].'

For the arable lands and pasture-grounds the course of the struggle is as follows. Yima tries to take by force from the daivas the districts suitable for thriving settlements in order to make them over to his own people. This was undoubtedly

[1] Ys. XXIX, 4; cf. also supra, Yt. V, 22, next the formations *daeva, mashya, yātu, pairika, kavi, karapan*, near them we also find sātar 'the destroyer, the enemy,' Ys. IX, 18; Yt. I, 10; V, 13 &c.

[2] Rv. II, 20, 7; V, 31, 7; VI, 21, 11, &c.

[3] Vd. VII, 56, '... he is a *daiva*, a worshipper of the *daivas*, one who holds intercourse with the *daivas*, one who adheres to the *daivas*.' Cf. Vd. VIII, 31.

[4] Yt. V, 26.

the beginning and the earliest phase of the war of races. The legend then goes on to ascribe to Zarathushtra the complete destruction of the daivas. Formerly they roved in human form about the earth, but after the advent of the prophet they disappeared and could only exercise their destructive influence as disembodied beings[1]. Where the Irānian people thus gradually emerge from the dawn of legend into the brighter light of an historical age, the daivas and the battles with them are removed to a supernatural and superhuman region, and lapse into all-deforming myth. At the period of the foundation and of the flourishing estate of the Mazda-religion the dominion and independence of the non-Arian tribes are already broken down, they have either disappeared from the soil and been destroyed by the Irānians, or they still subsist merely as the last survivors who have adapted themselves gradually to the laws and ideas of the victors, and who pursue a peaceful trade amidst the ruling classes of the Arians, without being any longer savagely persecuted by them but yet without enjoying equal rights.

We have already spoken of the *Māzanian daivas*. Whether their name bears any relation to that of the present province of Māzenderān cannot be proved with certainty; however, it is not impossible. Māzenderān, on account of its extremely unwholesome climate and its marshy soil, which was certainly covered in olden times with impenetrable forests, may have remained free from the settlements of the Arians, and have served as a place of refuge to the conquered aborigines. In the legend of Firdūsī, also, Māzenderān is regarded as the dwelling-place of demons, as prominently appears from the narrative of the march of Kaikāus to that country[2].

It is with the *Māzanian daivas* that Haushyangha

[1] Ys. IX, 15, 'Thou, O Zarathushtra, didst make * all demons, * who before roamed about the world in human forms *, conceal themselves in the earth.'

[2] *Firdūsī, Shāh-nāme*, ed. by Vullers, vol. i, p. 315 seq.; Spiegel, *E. A.* vol. i, p. 585 seq.

principally fights—the very hero of the Irānian legend who subdued the wicked people of Varna. He thus invokes the genius Druvāspa·

> 'Grant me, that I may overpower all *Māzanian daivas*, that, terrified, I may not give way through fear before the demons. Before us may all *daivas* in alarm give way against their will, terrified may they fly unto darkness[1].'

Together with the *daivas* are to be named the *drujas*, monsters which are also, as I believe, to be understood in very many cases as human beings, and indeed as race-enemies of the Arians. We read frequently in the Gāthās·

> 'For that reason do I ask Thee; give me a correct reply, O Ahura:
> How can I deliver the monsters into the power of the pious
> In order to slay them according to the commandments of Thy Doctrine,
> In order to cause a mighty overthrow among the wicked?
> I will deliver them up, O Mazda, to Danger and Misery[2]!'

So also in the later Avesta, when the bullock, carried off by the nomads of the steppes, complains to Mithra that he has been led away into the abode of monsters[3]; or, when the 'monsters of Varna,' who may probably, however, be identical with the evil people of Varna, are expressly distinguished from the 'invisible monsters,' the wicked spirits[4].

Two results may be deduced from the above facts. The Avesta in no way contravenes the belief in a primitive race in Irān foreign to the Arians, but lends it a noteworthy confirmation. 'Non-Arian' tribes are expressly mentioned in the Zoroastrian documents. We furthermore

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[1] Yt. IX, 4; XVII, 25; cf. Vd. XVII, 9.
[2] Ys. XLIV, 14. [3] Ys. X, 86.
[4] *Varenya - dravaiñti · druj, mainyava · druj*, Yt. I, 19.

arrive, through the Avesta, at the result to which modern interpretation of the Rig-veda has brought us. In many passages where mention is made apparently of monsters or demons, we have to deal, not with superhuman incidents, but with absolutely real and to a certain extent historical events. The same expression which designates the dark powers of Hell, the demoniacal enemies of the bright, beneficent deities of light, denotes also the enemies of mankind, and, indeed, especially those enemies with whom the Arians were united by none of the ties of blood, custom, religion, or language, and who might therefore, with some show of reason, be regarded by them as the embodiment of the power hostile to God—the non-Arian tribes whom they subdued in the earliest period of their immigration in the fierce war of races.

## § 3. *Character of the Adversaries of the Avesta People.*

IN particular cases it is naturally no easy matter to distinguish between those enemies of the Avesta people who, living as nomads, differed from them only in their economic status, and those who belonged to a foreign tribe. The following may be considered as a criterion at least occasionally applicable. As the war with the primitive race is as a rule laid in the legendary period, that is, in a past time remote from that of the Avesta, we are probably right in holding, where the Avesta speaks of existing circumstances, that the conflict is generally one between husbandmen and nomads. But where the events of an earlier epoch are described, there remains the possibility of allusion being made to a difference of race. At all events it is beyond question that in the Avesta national conflicts, as opposed to social ones, are only of secondary importance.

In this Section, therefore, I shall only mention in general those enemies who threatened the peace and security of the Avesta people, without considering whether they belonged to the Arian race or not.

These enemies were bodies of horsemen, who had their real abode and place of refuge in the desert. Mounted on swift horses, they broke suddenly into the settled and well-cultivated districts of the Zoroastrians, and surprised their villages and hamlets. Whoever offered resistance was slain, the remainder, as well as the women and children, were carried off into captivity. The main object of these inroads, however, was simply to make booty of the herds of cattle, which were driven off by the robbers into the oases of the steppes, where all pursuit was vain[1].

Such conditions of life vividly recall to mind those which existed down to very recent times on the north-eastern frontiers of Persia, and which have only very lately been gradually brought to an end through the extension of Russian dominion in Central Asia. As in ancient times the settled dwellings of the Avesta people were invaded by the nomadic tribes of the North, so in Khorāsān up to our own times the villages and estates of the Persians were liable to the inroads of the Turcomans. The object of the plundering excursions of the Turcomans is likewise to rob their more wealthy neighbours, and to carry off cattle and slaves. They owe their success more to their sudden and unexpected attacks, which cause the greatest panic and confusion among the Persians and cripple their power for resistance, than to their personal courage and resolution. The effects of such attacks are horrible, and travellers like Ferrier, Vámbéry, M'Gregor and others are able to describe dreadful scenes, which they have either heard of or witnessed with their own eyes[2]. The insecurity of life and property has here reached such a height, that the most flourishing and most fertile districts of Irān have become gradually

[1] The dwellers near the banks of the Rangha, the Jaxartes, probably nomadic tribes of herdsmen, are expressly designated (Vd. I, 20) as *taozhya* ( = N.P. *tōz*) 'robber-like, rapacious;' *taozhyācha · dag̃hēush · aiwishitāra*.

[2] Comp. the collections by Marvin, 'Merv,' p. 177 seq.; on the system of attack and the mode of fighting of the Turcomans see particularly Ferrier, *Voyages*, vol. i, p. 162 seq.

depopulated, and remain wholly uncultivated and useless. In many districts ruined villages are met with in close succession. The remains of waterworks and canals show that industry is declining. In some parts hardly a single family is to be found which has not had to lament the loss of one or more of its members, who have either perished during a raid or are pining in slavery among the Turcomans.

If however the Persians at the present day are everywhere at a disadvantage on the frontiers of Khorāsān, and do not even show themselves capable of making corresponding reprisals, the case must have been different in more ancient times. According to the Avesta, the princes of the Arian districts assembled and opened a regular campaign against their enemies, in order to exact a bloody vengeance for all their encroachments[1]. If we were to press this passage, we might even infer from it that the enemies referred to must have belonged to a non-Arian tribe.

An allusion to the marauding and plundering expeditions of the northern barbarians is contained in the following passage:—

> 'What is, fifthly, most unpleasant to this earth?—When pious men, O Spitama Zarathushtra, and women and children are driven into captivity along the sandy, waterless way, and, complaining, raise their voice[2].'

Here is evidently represented such a band of robbers on their way back to their sandy steppes from a successful raid The captives are dragged away in fetters, and with tears and wailings they follow their cruel victors to a hard, life-long bondage. We can scarcely believe that two or three thousand years have intervened between the time when these descriptions were written and quite recent days, when the missionary Wolff, in his well-known 'Travels,'

[1] Yt. X, 8.

[2] Vd. III, 11. Observe the expression *varaithīm · pañtãm · pãs-nvãoghem · hikvãoghem*, 'the dry and dusty way leading to captivity,' i. e. into the desert!

depicted scenes in every way similar, experienced and witnessed by himself in the same land[1].

As a designation of the nomads of the deserts who set out for plunder, the word *haęna*, 'army' or 'hostile army,' is pretty often used in the Avesta. In this context the word corresponds perhaps to the modern *Al-amān*, the expression for the plundering expeditions of the Turcomans. It may be conceived that nothing was so much feared, nothing so much an emblem of horror and terror, as a surprise by the *haena*.—

> 'Whoever should give a wicked, impious enemy of the pious, the pressed juice *Haoma*, or of the consecrated food for the sacrificial festival meal, does no better work than if he led the *haęna*, consisting of a thousand horse, against the villages of the Mazdayasnān, slew the men, and dragged away the herds of cattle into captivity[2]'

The nature of the *haęna* is clearly characterized in this passage, more especially by the descriptive epithet 'consisting of a thousand horse.' Elsewhere it is styled 'with broad lines of battle, malicious, surprising[3].' The enemy

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[1] Wolff, in Marvin, 'Merv,' p 238 I cannot forbear quoting the description which the passage before us so strikingly recalls: 'Wolff was accompanied by Bokhara merchants, who had bought at Sarakhs two Persian boys as slaves, whom they were going to bring to Bokhara to sell. The one was seven years of age, and the other nine. The Turcomans universally call the Persians Guzl-baash, i.e. "Red-head." Wandering through the desert the two poor Guzl-baash slaves were singing in the morning, and during the day, and in the evening, in plaintive strains, the following words:

"The Al-amaan has taken us,
Poor, poor Guzl-baash!
And carry us, and carry us
In iron and chains, in iron and chains
To Oorgantsh and Bokhārā."

Thus they proceeded through the desert, continually hearing that plaintive strain.'

[2] Vd. XVIII, 12; *hazagrō-aspām · haenām.*

[3] *Haęnayāoscha · perethu-aimkayāo · davāithyāo · patāithyāo.* Ys. IV, 18.

is thus a force of cavalry, scouring the country in detached bands, not fighting man to man, but conquering through cunning surprises and sudden attacks, not by heroic valour The *haena* also bears banners and standards[1]; and I may here remind the reader that the Turcomans also, I believe, carry field-ensigns, although their employment generally presupposes a certain amount of tactical knowledge and an organized mode of fighting.

On the other hand, it appears somewhat incongruous to find the *haena* mentioned as using war-chariots[2]. The nomads of the steppes certainly fought in that age, as they now do, on horseback only, the use of war-chariots points to more civilized nations. The writer therefore is either speaking of hostile armies in general, and not especially of the hordes of the deserts, or else he arbitrarily transfers the conditions and methods of his own people to other tribes.

The appearance of the enemy, as it was mostly a sudden surprise, naturally inspired terror and consternation[3]. Only through divine assistance was it possible to master the dreaded and hated foe:

> 'When Mithra drives against the terrible, hostile armies, against those so assembled for fighting in the battle of the country. Then does he fasten behind their backs the arms of those who have broken their engagements; then does he veil their sight and deafen their ears[4].'

[1] 'Before the wicked armies of the enemy, they bear the bloody banners (*khrūrem · drafshem*),' Yt. X, 93; Ys. LVII, 25 Cf. *perethu-drafsha, uzgereptō-drafsha, khrūrem · drafshem · barat* Yt. XIII, 136.

[2] *Ratha · haenya.* Yt. VIII, 56, XIV, 48.

[3] *Vōighna*, comp. Skr. *vij*, part. *vigna*, 'perplexed, confounded.' Ys LXVIII, 13, *pairi · haęnayāoscha · vōighnābyō*, 'before the terror which the *haena* calls forth.' In Ys. LVII, 14 *vōighna* is akin to *aghāo · ithyejāo*, 'evil, corruption;' in Ys. VIII, 56; XIV, 48 near *haęna, pāman, kapasti, haenya ratha, uzgerepta · drafsha.*

[4] Yt. X, 48, *avi · haęnayāo · khravīshyeitīsh* · (similarly Yt. XV, 49; XIX, 54).

Naturally, it was the herds of the settlers that the nomads more especially hankered after. The main object of all the plundering incursions and surprises of the nomadic hordes was to gain booty, as was generally the case in all the wars of those remote ages. They found it more convenient to seize from their settled neighbours what they required, than to occupy themselves with the troublesome work of rearing cattle in a regular and systematic manner. If we consider what value the Avesta people attached to their herds, we can conceive why the loss of those dearest of possessions is lamented in the following strain:

> 'On that blood-stained path into captivity wanders the cow, that goes upon hoofs, when she falls into the power of the breakers of covenants[1].'

> 'The cow that is driven away as booty, implores him (Mithra) for help, longing to return to her stalls: "When will the valiant one, driving us from behind, bring us back into our stall, O Mithra, the master of wide fields? When will he lead us to the paths that belong to the pious, us who are dragged away into the abode of the demons[2]?"'

## § 4. *Names of Nations in the Avesta.*

We have an interesting passage in the *Farvardin Yasht* which enumerates the most important nations in Irān. It runs as follows, omitting superfluous repetitions:

> 'We praise the *manes* of the pious men and of the pious women of the Arian countries, of the Tūrānian countries, of those of the Sarima, of those of the Sāni, and of those of the Dāhas[3].'

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[1] Yt. X, 38. The 'breakers of covenants' *mithra-drujō* (as elsewhere occasionally *anashavan*, *drvat*, &c.) stand evidently for *haęna* here, as in the passage (Yt. X, 48) translated above.

[2] Yt. X, 86, *vide* Geldner, *Metrik*, § 104.

[3] Yt. XIII, 143–144.

If we take this passage quite literally, we must at any rate assume that the Arians are here contrasted with the Tūrānians, the Sarima, the Sāni, and the Dāhas, and that the latter, therefore, do not belong to the Arian race. Here, however, I must first of all observe that so far as I am aware no further proof can be adduced from the Avesta for the non-Arian descent of the nations above-named.

I begin with the Tūrānians. At present we use this name ethnographically for the Tatarian nomadic tribes of Central Asia. But this application is arbitrary, and is in nowise confirmed by hints gathered from the Avesta. Nor is the practice justified by Firdūsī. Indeed, the name *Tūra* appears to have always been regarded by the Irānians, from the Avesta to the Book of Kings, as a collective idea which did not indicate any ethnographical division, but comprised the peoples of the steppes from the Caspian Sea to the Sir and beyond it. The remains of an aboriginal population of Tatars may thus indeed have formed part of them, just as may have been the case also with the Scyths of the Greek authors, but they must in all likelihood have been chiefly Arians.

The Tūra are mentioned in the Gāthās; but, owing to the recognized difficulty of those texts, we must not attach too much importance to such an isolated passage. I believe it to mean that a family from that tribe, namely that of the *Fryāna*—the name is altogether Irānian—became converted to the Zoroastrian faith and adopted a settled life:

'When pious people in the family and amongst the kinsmen
Of the praiseworthy Tūrānian *Fryāna* arose,
Who increased zealously the settlements of the good:
Then settled with them together with the Spirit of the Good Mind
Ahura Mazda, and ruled over them, to their joy[1].'

[1] Ys. XLVI, 12.

Elsewhere also the Avesta speaks of pious men amongst the Tūrānians as well as amongst the Dāhas[1], and if this does not prove the non-Arian descent of those tribes to be an impossibility, it at least renders such a belief essentially more difficult.

As horsemen the Tūra are characterized by the epithet 'with swift horses,' but the passage in which it occurs is not perfectly clear[2]. Against the 'Tūrānian countries' Tūsa, the Tūs of Firdūsī[3], takes the field. But all the oppressions and injuries which the settlements of the Avesta people had to endure from their turbulent neighbours of the Caspian deserts are personified in the Tūrānian prince *Frangrasyan*, the Afrāsiāb of the Shāh-nāme, who, after protracted and desperate struggles, was finally overpowered by *Kavi Husrava*, Kai Khosrav, the king of the Irānians. Firdūsī naturally pictures these events in his accustomed manner as great wars in which innumerable heroes appeared on both sides in order to mutually test their strength and valour—thus altogether in the tone and style of a chivalrous epoch. The substance of these ancient legends he transforms with artistic hand according to the taste and conceptions of his own age[4]. In the Avesta the case is otherwise. It describes the battles with Frangrasyan and the Tūrānians more mythically, a proof that they had taken place in a

[1] Yt. XIII, 113, 123, 143. The names *Arejaghat* and *Frārāzi*, which occur here, have a thoroughly Irānian sound.

[2] *Āsū-aspa*, Yt. XVII, 54.

[3] *Tūiryāo dahhāvō*. Yt. V, 54; comp. Spiegel, *E. A.* vol. i, pp. 576, 620 seq.

[4] When Firdūsī describes the state of civilization among the Tūrānians in entirely the same terms as that of the Irānians; when he makes them dwell in towns and castles with magnificent buildings, walls and towers; when he represents the king as standing at the head of his people surrounded by his retainers—all this is manifestly a simple modernism, an anachronism frequent in the *Shāh-nāme*. According to Firdūsī, Irānians and Tūrānians are moreover cognate. They derive their descent from Frēdūn, whose three sons—Selm, Tur and Eraj—were the ancestors of the Western people, the Tūrānians and Irānians. *Vide* Spiegel, *E. A.* vol. i, p. 546 seq.

period even then remote, and were at least almost at an end when the Avesta was composed. Thus it is the *yazata* Hauma himself, who delivers his enemy into the power of Husrava:

> 'To her, to the Druvāspa, did Hauma sacrifice . . . and beg of her this boon' "Grant me . . . , that I may fetter the destructive Tūrānian Frangrasyan, and that I may bring him bound and in chains before the Kavi Husrava, so that Kavi Husrava may kill him behind the sea Chaichasta, the deep, wide-flowing[1]."'

Further on, the battle with Frangrasyan is pictured in a mythico-symbolical way and is described as a struggle for the 'majesty' or the 'heavenly splendour'—the *hvareno*. This is evidently the symbol and token of supreme power. When Frangrasyan fruitlessly endeavours to seize the *hvareno*, we are probably to understand merely the tribes of the deserts that vainly strive with and endeavour to subdue the settled population.

That *Tūra*, however, has a tolerably general and comprehensive signification[2] we gather from the simple fact that the name is interchangeable with similar collective appellations, or may appear in the place of names of individual tribes. Thus it is used as quite synonymous with *Dānu*, which evidently designates only the enemies of the Avesta people, be they Arians or non-Arians, in one word the 'barbarians.'

> 'We adore the good, sublime, blissful Fravashis, the *manes*, who form many armies, carry hundreds of weapons, who bear banners—the radiant ones, who in mighty battles come rushing down, who, armed and steadfast, fight battles *against the Dānu*. Ye have overpowered the resistance of the *Tūrānian Dānu;* ye have subdued the enmity of the Tūrānian Dānu[3]!'

[1] Yt. IX, 17–18.

[2] Justi (*Handbuch der Zendsprache*, s. v.) derives *tūra* from *tauru*, *taru* = Skr. *turv*, *tūrvati*.

[3] Yt. XIII, 37–38. According to Yt. V, 73–74 (*yat · bavāma ·*

In the course of this description the Dānu are styled 'having ten thousand (i. e. *innumerable*) princes.' This name shows that they were divided into a multitude of small sections and bands, each of which was ranged under one single chief unrestrained in his absolute power by any higher authority. This is a common feature of nomadic life, while settled tribes aspire to a concentration of authority by which the heads of the several individual sections of the people are in turn subject to one prince or king who stands above them; it is also particularly characteristic at the present day of the populations inhabiting the steppes of Turkistān.

From a historical point of view the word *Dānu* is of special interest, for this name is also found in the Rig-veda, as well as Dānava, another form of it. According to the dictionaries, it is a designation of the demons, foes of the gods, who are opposed by Indra. But I believe that here, as with the name Dāsa—of which we shall speak further on—we must accept as the original meaning 'opponent, enemy[1].' The united Indo-Irānians seem to have designated as *Dānu* the tribes not akin to themselves with whom they came in contact during their march from North to South. After the separation, the Irānians retained the name as a comprehensive appellation for all Tūrānians, that is, nomadic tribes on their northern frontiers; the Indians applied it chiefly to the non-Arian aborigines of the valley of the Indus and of the Panjāb, and extended it also to the enemies of the gods after the usual manner of ascribing earthly conditions to the supernatural world[2].

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*aiwi-vanyāo · dānavō · tūra · vyākhna ·*) the Dānu are vanquished by *Ashavazda* and *Thrita*. Here are also mentioned, as it seems, the names of Dānu-heroes—*Kara Asabana*, *Vara Asabana*, and *Duraekaeta*—of which the last at all events has a true Irānian sound.

[1] *Dānu* is to be derived, just as *dāsa*, from rt. *dā*, 'to cut, to cut into pieces, to annihilate' (cf. Grassmann, *Worterbuch*, s. v.).

[2] *Dānu* designates a demon, e. g. Rv. V, 32. 1, 4, 7, where it is used together with *Çushna* (*vide* Ludwig, *Einl.* 337), further I, 32, 9, and perhaps X, 120, 6.

For us the former, or historical meaning, so to speak, of *Dānu*, is more important than the mythological one. It is found in a song abounding in references to actual events·

'Wast thou not also, *Vritra-killer*
O sublime one, quite filled with wrath,
When thou didst slay the *Dānu* (the enemies)[1]?'

In another hymn, moreover, the subduing of the Dānu is placed on the same level with the overpowering of the *Dasyu*. That by the latter name the non-Arians of the Panjāb are meant probably no scholar will deny. I do not therefore see any reason why we should not recognize historical events in the entire strophe, instead of assuming a strange amalgamation of things human and superhuman.

'Take, O strong one, the strength with which the enemies
Thou didst slay, the spider-brood of the Dānu;
With which thou didst reveal the light to the Arian tribe;
On the left sank the Dasyu tribe, O Indra[2]!'

That *Tūra* must be understood as a collective name, we see further from the fact that the tribe of the *Hunu* is also spoken of as a Tūrānian one:

'To Ardvi-sūra Anāhita did the armed Tūsa, the warrior, sacrifice, sitting on the back of his horse, imploring strength for his teams, and health for himself, protection against his enemy, the defeat of his adversaries, the entire subjection of his opponents, the wicked, hostile ones. And he prayed to her for this boon: "Grant me, O good, beneficent Ardvi-sūra Anāhita, that I may vanquish the armed *Hunu* in Vaiska near the defile Khshathrō-sauka, that lies high up in Kangha, the sublime holy one, that I may kill them in the Tūrānian countries in hundreds and in thousands, in myriads and in innumerable multitudes[3]."'

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[1] Rv. IV, 30, 7.

[2] Rv. II, 11, 18, *dānum · aurṇavābham*. With the last word comp. Grassmann, *Worterbuch*.

[3] Yt. V, 53–54, 57–58; according to the obscure and difficult

The above translation of the passage, according to which *Hunu* would be the name of a tribe, is at all events a simple and approximate one. But it is often disputed, as *hunu* is considered to be the Irānian equivalent for the Indian word *sūnu*, and is translated by 'son.' I must admit that in the present case that sense does not quite satisfy me. Whose sons are thus vaguely referred to? There is a genitive wanting, which is absolutely necessary to complete the sentence. If, on the contrary, my own view is correct, the passage contains a most remarkable hint well deserving of attention. It mentions a tribe of horsemen[1], who are grouped with the Tūrānians, the tribes of the Northern steppes, and mentions as their dwelling-place the territories lying half-way up the Sir-daryā, where the existence of a Tatar tribe may be most easily and safely accounted for. Under such conditions one feels inclined to compare the Hunus of the Avesta with the later Hunns. In that case there would probably be no older testimony than the religious documents of the Zoroastrians to prove the existence of that energetic tribe, which later on exercised such a mighty influence on the history of mankind. But it is very dangerous to argue similarity of name, and it cannot be denied that weighty historical reasons are opposed to this hypothesis. The Hunns belong, in fact, to a much later epoch than the period of the composition of the Avesta, which moreover places the battles with the Hunns in the heroic age of the Avesta people. Even the white Hunns, who are mentioned by Haug, first appear in the last few centuries before the Christian era, when they drove the inhabitants of the Northern steppes towards the South[2]. We need only assume that the Hunns, as a nomadic tribe, roved all about the steppes

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passage Yt. XIII, 100; *Kavi Vishtāspa* also was engaged in war with the Hunus (Yt. XIX, 86).

[1] Hence *aurva-Hunavō*. Of interest is also Yt. XIX, 41, *Hunavō-yat-pathanya* (Skr. *patheshthā*, 'being on the road, waylayers') 'the predatory Hunus.' The context of the passage is indeed very difficult and obscure.

[2] Comp. particularly Justi, *Handbuch*, s. v. *hunu*.

of Central Asia even in the remotest antiquity, and that they made themselves dreaded by isolated incursions long before they became notorious by their inroads on a large scale and by immigrating in large numbers amongst the tribes of Western Asia and of Europe. But under all circumstances I strongly maintain my view that the word *hunu* is the name of a tribe, whether or not that name be identical with that of the later Hunns The interpretation of the text itself is not at all affected thereby.

As regards the *Sarima* and *Sāni* little can be positively asserted, since they are never named in the Avesta except in the passage cited above[1]. We must thus confine ourselves to conjectures, based upon the greater or less similarity to the sound of the name. By the *Sarima* tradition apparently denotes the peoples of the West. At least Firdūsī makes Selm, whose name may be identical with Sarima, a sovereign of the Western countries. According to the Book of Kings, the kingdom of Frēdūn was divided among his three sons, Selm, Tūr, and Eraj; the first received the West, Tūr the North, and the last Irān Proper[2]. As there is evidently a play upon the name here, we should do well not to overrate the historical value of this statement. The Sarima have been compared with the Sarmatians or with the Solymi[3]. As the former, according to the statements of Ptolemy and Strabo, must have dwelt on the plains near the lower course of the Don and the Volga[4], we should have at least to assume that they had wandered in course of time from East to West. For if they had already dwelt, in the period represented by the Avesta, where the Western writers look for them, the Avesta people would scarcely have been able to come in contact with them. In

[1] *Sairima* indeed occurs in the *Vishtāsp-Yasht* (Yt. XXIV, 52), which is admitted to be thoroughly corrupt.

[2] Spiegel, *E. A.* vol. i, p. 546.

[3] Justi, *Hdb.* s. v.; Spiegel, *Avesta ubersetzt*, vol. iii, p. 139, n. 1 and 2; Windischmann, *Zoroastrische Studien*, pp. 229–230: cf. also de Harlez, *Av. tr.*, iii, 41, n. 2.

[4] Kiepert, *Alte Geographie*, § 306; Forbiger, *Handbuch der alten Geographie*, vol. ii, p. 452 seq.

the same way I believe that the Solymi who had settled in Lycia[1] were too remote. Personally I am inclined to consider the name Sarima to be a similar collective expression, like Tūra, for the different nomadic tribes of the North, and to give it as general a meaning as possible. I should translate it by 'archers[2],' which meaning appears to be applicable from the fact that nomadic tribes are generally distinguished for their use of the bow, a peculiarity which is specially recorded of the Scyths.

As regards the *Sāni*, they have been identified with the Soanes on the south of the Caucasus. Justi reminds us of the city of Sān, which, according to Persian lexicographers, is supposed to be situated in Kābulistān or in Balkh. But no cogent proof can be brought forward in support of either view[3].

We now come to the *Dāha*. It is probable that the Avesta denotes by this name the Daai of the Greek historians and geographers. They are reckoned amongst the Scythian tribes that dwelt in Northern Hyrcania, east of the Caspian Sea. They extended as far as the Oxus and the Jaxartes, and Herodotus even speaks of the Daai as inhabiting the province of Persis. Consequently, they were widely spread and considerable in number, and, moreover, at the same time a 'warlike people, who served Darius Codomanus as cavalry, and Alexander and Antiochus as mounted archers[4].'

In the Rig-veda the name of Dāha is found under the equivalent Indian form Dāsa, and here we meet with linguistic coincidences similar to those we have already become acquainted with in the case of the Dānu.

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[1] Forbiger, *H. a. G.* vol. II, p. 248.

[2] From Skr. *çarya* or *çaryā*, 'arrow.'

[3] I derive *Sāini* from the rt. *sā*, which is also the origin of the word *sālar*, 'the enemy.' Thus the name generally bore the same meaning as Tūra.

[4] Kiepert, *a. G.* § 61; Forbiger, *H. a. G.* ii, p. 570, note 13; Strabo, pp. 304, 511, 515; Herodotus, I. 125; Arrian III. 11, 28 ('the Daai living on the other side of the river Tanais—this river is mistaken for the Jaxartes,—the Daai on the banks of the Tanais,' cf. III. 30); V. 12; Curtius, viii. 3.

Scholars were formerly inclined to hold the fundamental meaning of Dāsa to be 'monster, demon hostile towards the gods,' and that meaning was adopted in the majority of passages. The aboriginal inhabitants of the Panjāb are said to be only secondarily designated *Dāsa*, because they opposed the immigrating Arians in a hostile manner. This view interpreters have more and more tended to abandon[1]. The correct process is quite the reverse The natural course to follow is not that which leads from heaven or the ethereal regions down to the earth, or from the realm of the supernatural to that of the sensual, but the opposite one. Men took the circumstances of their own immediate surroundings, what they daily saw and experienced, for their starting-point, and transferred human conditions, representations, and ideas to spiritual and heavenly objects. By Dāsa in the Rig-veda is meant first of all an enemy, especially an enemy of the Arians, an enemy of foreign race, and this is certainly the sense in the great majority of passages. It is only in a secondary sense that it is used as a designation for the enemies of the benevolent gods—the demons, whose destructive influence the fancy of mankind recognizes in scorching heat and drought, in the raging storm-wind, in the burning and destructive lightning-flash, in the dark night of the thunder-clouds. As regards the use of the word *Dāsa* in the Indo-Irānian period the same remarks are applicable as those above which concern the name *Dānu*. After the separation of the two Arian tribes the name appears to have been used so far differently by the Irānians, that it was evidently restricted to a special tribe, and no longer used as a designation for all the enemies of the Irānian people.

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[1] Ludwig, *Einl.* p. 207 seq.; Zimmer, *AiL.* p. 100 seq. The former has described the state of affairs quite clearly in the words: 'Wherever Dāsa and Ārya stand opposed to each other, we may invariably consider the former to belong to the aboriginal inhabitants; where, on the contrary, demons alone should be understood, cannot in that case be easily settled. Only so much appears to us certain, that the latter are to be understood much more rarely than is done in the present system of interpretation.'

Names of tribes may be further contained in *Adhyu* and *Dadhıka*. The latter have been excellently compared by Spiegel with the Dadikai of Herodotus [1]. As they are constantly named together with those mentioned above [2], we may well regard the Adhyu as a tribe likewise, provided the comparison be correct. The Avesta does not furnish us with any more precise explanation; at most we may regard it as probable that they belonged to the Irānian nation, and that the Zoroastrian doctrine had found entrance among them. According to Herodotus, the tribe of the Dadıkai seems to have taken part in the great campaign of Xerxes against the Greeks. It was closely united with that of the Gandars who were settled among the present Suleiman mountains, and formed one assessment dıstrict with them [3]. Their place of abode is thus probably to be looked for in the neighbourhood, perhaps in the dominion of Ghazna, though in other cases also tribes living at a distance from each other belonged to the same district.

The *Vardhaka* and the *Hyauna* were enemies of the Avesta people, and were conquered by Kavı Vıshtāspa. However, it is not easy to interpret the passage in which this fact is strikingly suggested [4]. Under the name of Hyauna are reckoned *Arjat-aspa*, as well as *Tānthravat*, 'the dark one,' and *Peshana*, 'the fighter.' These names are purely Irānian, and if their bearers neither assumed the titles themselves nor received them from the Avesta people, the Arian nationality of the Hyauna can no longer be doubted.

> 'The armed Kavi Vishtāspa subdued the *Tānthravat*, the adherent of the false doctrine, and the *Peshana*,

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[1] *E. A.* vol. ii, pp. 380–381, note.

[2] *Aidhyu*, *Daıdhıka*, Ys. XXXIX, 2; Yt. XIII, 154; but in Yt. XIII, 74 *daidhıka* is represented in a somewhat striking connection.

[3] Herodotus, VII. 66; III. 91.

[4] *Varedhaka*, *Hyaona*, Yt. IX, 30–31; XVII, 50–51 (here also *hyaunimām* · *dahyunām*, 'of the Hyaunıan dıstricts'). Spiegel (*E. A.* vol. iii, p. 283 note) compares with the Hyauna the Chionites who lived on the western side of the Caspian Sea.

the demon-worshipper, and the *Arjat-aspa* and all the other wicked *Hyauna* bent upon harm[1].'

I am conscious that I am putting forward a mere hypothesis; but it seems to me deserving of examination. In the list of countries of the Vendidād (often mentioned) the counter-creations of the Evil Spirit are named, as we know, together with each district. in *Aryana-vaeja*, extreme cold; in India, excessive heat; in *Haitumat*, the 'sins of *yātu*' But at the same time it is also said with regard to several provinces, that in them unbelieving and hostile tribes were the scourge of the land; *Urva* has evil people, the country near the *Rangha* predatory inhabitants, and *Varna* in the Alburz mountains a non-Arian population. This leads me to consider whether the names of tribes might not be directly conjectured from other expressions which are found in that connection, and which frequently offer a formidable *crux interpretum*.

In the case of *Moru* (Merv) *maredha* is denoted as the calamity created by Angra Manyu[2]. Herein I recognize the name of the tribe of the Mardoi. These must have lived within the limits of Moru and must have harassed that district by pillaging expeditions. Their character is sufficiently indicated by their name; for *maredha* signifies 'murderer[3].'

The Mardoi or Amardoi—for even Strabo expressly declares that the two names are identical[4]—had, like the Daai, spread very widely and were found, according to Greek authorities, in the most diverse countries of Western Asia. We meet with Mardoi in Hyrcania, where

[1] Yt. XIX, 87; comp. Yt. V, 109.

[2] It is said in Vd. I, 6; *āat · ahē · paityārem · frākerentat · Agrō-mainyush · pouru-mahrkō : vīthushāmcha · maredhāmcha.* To my mind a correction into *maredhācha* or *maredhācha* is absolutely necessary; *ām* actually served only as a sign of the nasalized *ā* in the accusative plural. One is tempted also to hold *vīthushāmcha* to be the name (perhaps mutilated) of a nation.

[3] From root *mared*; comp. also Haug, in Bunsen, *Aegyptens Stellung in der Weltgeschichte*, v, p. 129.

Strabo, p. 523.

they dwelt in the inaccessible mountain-passes of the Alburz, perhaps in the vicinity of Demāvend; and also in the mountains of Persis. Against both those tribes Alexander the Great fought; against the former he took the field from Zadrakarta the capital of Hyrcania, against the latter from Persepolis. There were Amardoi in Bactria and Scythia; they may also have dwelt in Margiana; Maidyeni are mentioned as living in Sogdiana[1]. They were probably the mere remnants of a distinct tribe which formerly roved about the border of the habitable districts of Eastern Irān towards the deserts.

More interesting still is the name of the Derbikes, which I find again in the Old Irānian *Driwika*. The Driwika are regarded as a counter-creation in *Haraiva*[2], which seems to be in complete harmony with the statements of Western writers, according to whom the Derbikes dwelt in the north of Margiana[3]. They may perhaps have occupied the territory between Merv and Sarakhsh. They are described as a nomadic people in so low a stage of civilization and with such coarse and strange manners and customs that they can hardly be considered Arians. 'They worship the Earth as their deity, sacrifice and use as food no female beasts, slaughter and eat (!) old men of over seventy years of age[4]; whilst they hang old women and then bury them.' This sounds too cannibalistic not to rouse a suspicion that it is incredible. Still the narrative cannot be wholly without foundation, and if true only in part, it is still sufficient to set in a clear light the barbarous condition of the Derbikes.

There is a very striking correspondence between the

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[1] Forbiger, *H. a. G.* vol. ii, p. 595, note 20; Spiegel, *E. A.* vol. ii, p. 538 note.

[2] Vd. I, 9, *āat · ahē : paityārem · frākereñtat. Ağrō-mainyush · pouru-mahrkō : saraskemcha Driwikācha* ('hail-storms and the people of the Driwika').

[3] For particulars, see Forbiger, *H. a. G.* vol. ii, p. 566.

[4] The same is recounted of the Massagetae (*H. a. G.* vol. ii, p. 467, note 16) and of certain Indian tribes (p. 494).

name Derbikes and the proper name *Drbhika* in the Rig-veda to which Ludwig refers[1]. This occurs only in a single passage and there indeed in a somewhat mythical sense, which however is also sometimes the case with Dāsa and Dānu:

'Their priest, to him who slew the Drbhika,
Liberated the cows, opened the prison;
To Indra, who resembles the storm in the atmospheric space,
Covered with Soma, as the horse with trappings[2]!

Through the discovery of the same name, as that of a tribe, in the Avesta, the history of the word is completed, and is found to be identical with that of Dāsa or Dānu. Originally, in the Arian period, the word may have had a pretty general meaning. I would translate it by 'beggar folk, poor rabble[3]' The Arians, who were proud of their well-cultivated fields and their rich stock of cattle, seem then to have contemptuously designated by this expression the homeless nomadic people without possessions, whom they met on their marches. Among the Indians the meaning of the name was evidently forgotten during their migration into the Panjāb; and this fact would explain how it came to be used by them in a semi-mythical sense. It was merely a relic of antiquity. It still retained indeed the idea of the frightful and the terrible, but its proper application, its original significance, was no longer known. Among the Irānians on the contrary Driwika served, as we have already seen to have happened in the case of Dāha, no longer as a general designation of all nomadic tribes, but as the special name of a single race[4].

[1] *Einleitung*, p. 207.

[2] Rig-veda II, 14, 3, Roth's translation (*B. R.* sub voce *jū*); quite differently Ludwig, Rv. II, 57.

[3] Cf. Avesta *driwi*, 'trash or trifle,' *drighu*, 'poor,' Skr. root *darbh*.

[4] By the way, I am here giving only a conjecture regarding the obscure word *bravara* or *barvara* in Vd. I, 7, which is called *paityāra* in Bākhdhi. I have long held it to be a name of a tribe;

The tribes which have so far been mentioned, dwelt either in Irān itself or in the countries on its northern border, which are generally comprised under the name Tūrān. Here, where desert and fertile land are in such close contiguity, the rivalry between the settled population and the nomads, and, at least partly, that between Arians and non-Arians must naturally have been keenest. Here from the earliest times occasion was given for continual quarrels, and here broke out in remote antiquity that desperate conflict, which, as the war between Irān and Tūrān, engrosses a great part of the legendary history of Persia, and which, though in an altered form, continued down to modern times.

The question now arises whether the Irānians were not also engaged in contest with hostile tribes in the East and West. In the region of the Suleiman mountains their territories apparently bordered on those of the kindred tribes of the Indians; and in the South-West, though indeed at a considerable distance, the Semites had established in the low country round the Euphrates and the Tigris a mighty kingdom whose military power was frequently felt by the inhabitants of the Irānian highland.

The Avesta seems to furnish hints of at least passing conflicts with Indian and Semitic nations; these, however, are in any case very doubtful and shrouded in myths and legends of many kinds. The Indian tribes are, I believe, comprehended in the *Gandarwa*, whose name can scarcely be separated from that of the mythical being Gandharva of the Rig-veda. The home of the Gandarwa is placed in the extreme East; he was re-

perhaps it may be the Irānian equivalent for the Greek Βάρβαροι (?) Now to my surprise I find the following notice in Grodekoff ('Ride,' p. 79): 'The road was intersected by the River Balkh, locally known as the Bandi-Barbari. Bandi means "beyond the pond" (?) —the dam is constructed at the town of Balkh itself—and the term Barbari is applied to the wild people living among the northern spurs of the Paropamisus and the Hindukush' (? comp. also Mod. Pers. *barbar*, for which the meaning 'fight' is given by the lexicographers: Vullers, *Lex. sub voce*).

garded as a terrible monster[1], bent upon killing the faithful, who was vanquished and slain in the valley of *Pishin* by the hero *Kersāspa*[2]. We may perhaps place Pishin in the province of Urva, belonging to the list of countries where 'wicked inhabitants' are expressly spoken of. We know also that the scene of other adventures and exploits of Kersāspa is laid in the South-Eastern territories of the Avesta people[3].

It is, further, generally assumed that the sufferings and miseries which came upon the Irānians from the Mesopotamian countries, particularly from Babylon, were embodied in the figure of *Azhi Dahāka*[4]. How much of a mythical element is contained in the legend of Dahāka may be clearly seen from the following passage describing the combat between Dahāka and his opponent *Thraitāna*:

> 'This blessing fell to the lot of Āthwya, this boon was given him that a son was born to him: *Thraitāna*, from his mighty race, who slew the dragon *Dahāka* with the three jaws and the three heads, with the six eyes and the thousand limbs, the all-powerful, devilish monster; whom Angra Manyu created on the living world as the strongest monster to annihilate the people of the pious[5].'

Many a passage may however be cited in confirmation of the historical basis of the myth of Dahāka. If the usual interpretation be correct, Babel, which is called *Bawri* in the Avesta, should be regarded as the dwelling-place of

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[1] Comp. the Κένταυροι.

[2] *Yō · ajanat · Gañdarewem * yō · apatat · vizafānō * merekhshānō · ashahē · gaethāo ·* 'who slew Gandarwa, who rushed downward with open jaws to annihilate the people of the pious,' Yt. XIX, 41. *Gandarewa* may be perhaps regarded as the name of a tribe (Yt. XIII, 123), just as *Tūra* which immediately precedes it.

[3] See pp. 81 and 113 of *Ostīrānische Kultur*.

[4] Justi, *Geschichte des alten Persiens*, p. 31; Spiegel, *E.A.* vol. i, p. 543 seq.

[5] Ys. IX, 7–8. The description of Dahāka as *daeva* and *druj* is interesting: compare what is said above in pp. 20–21.

Dahāka[1]. Another locality with which he stands in closer connection would be *Kvirinta*, which has been ingeniously identified by Justi[2] with the *Karina* of Isidor of Charax, the present Kerend at the top of the pass of Zagros. In perfect accord with this is the epithet 'difficult to approach,' indicating the strength and strategical value of the place, which was indeed of importance, since the Assyrian princes must have led their armies through it, when they took the field against the inhabitants of the Irānian highland.

The name of Bawri as well as that of Kvirinta may have been known to the Avesta nation only from hearsay, for no passage in our texts justifies the supposition that they had then advanced so far to the South-West.

The historical evidences of a real, though only transient supremacy of the Assyrian princes over Eastern Irān are, it must be confessed, very deficient. The Medo-Persian epic can indeed boast of mighty expeditions which Ninos and Semiramis undertook against the kingdom of Bactria, and tell of the fierce battles which preceded its subjugation. But these accounts can scarcely be regarded as genuinely historical, though they may have some foundation in fact. The Assyrian cuneiform writings only tell us of Tiglāth-Pilesar, who lived in the eighth century, that in one of his expeditions he advanced a considerable distance towards the East. In them also appear some highly interesting names: Arakuttu, evidently Arachotos-Harahvati, Nisaa-Nisaya and Zikruti, the Sagartians, in the list of conquered territories and nations; but these disappear again in the inscription containing the account of a later campaign and its result, a proof that the Assyrian dominion in Eastern Irān was not at all events of long duration[3].

[1] *Bawrōi*sh · *paiti* · *dañhaoyē* (?) 'in the country of Bawri,' Yt. V, 29. Therewith agree Hamza and the author of Mujmil, Spiegel, *E. A.* vol. i, p. 532.

[2] *Hdb.* sub voce. *Tem* · *yazata* · *Azhi*sh · *thrijafão*. *Dahākō* · *upa* . *Kvirintem* · *duzhitem*, 'unto him did the three-headed dragon Dahāka offer up a sacrifice on the scarce accessible Kvirinta. Yt. XV, 19.

[3] Duncker, *GdA.* vol. ii, p. 261; Maspero, 'History,' pp. 366–368.

Nevertheless, it is by no means incredible that the more powerful among the rulers of Babylon and Assyria endeavoured at least to bring under their sway the Eastern districts of Irān, and that they reached so far in their more distant expeditions. Furthermore, it is not impossible that such attempts gave occasion for the rise of the myth of Dahāka or in some way caused its transformation. The later legend also represents Zohāk as coming from Arabia[1]. That there was no permanent supremacy is proved by the Avesta itself. Dahāka is only for a limited period master over the Irānian nation, foreign rule soon gave way again to the national dominion originally founded by the hero *Thraitāna* or Frēdūn. Thraitāna had concealed himself among the heights of the Alburz, that is to say in the lofty mountains to the Eastward, which were at all times the place of refuge of the Irānians during hostile invasions. From hence, followed by the valiant body of his faithful adherents, he took the field against the usurper. defeated and killed him, and thus brought the foreign domination to an end.

If this view of the saga of Dahāka be correct, we have in it a peculiar commingling of legendary and purely mythological elements. If, on the one hand, it contains an historical nucleus, on the other it is certain that 'the dragon' signifies by natural symbolism the serpent of the clouds, and is identical with the *Ahi* of the Rig-veda, the demon of tempest, against whom the beneficent genii fight in storm and bad weather, in lightning and in thunder. Everywhere, in the Avesta as well as in the Rig-veda, the combats on the earth and in the air are confounded together. The Avesta also represents Dahāka in the figure of a serpent, while the later rationalistic legend describes him as a man with serpents' heads growing on his shoulders; it makes him three-headed with three jaws and six eyes, while he is also represented in the Yashts[2] as sitting upon a golden throne like an earthly potentate and king.

[1] Spiegel, *E.A.* vol. i, p. 531.
[2] Yt. XV. 10.

The relations, then, between the various populations of Turkistān and of Eastern Irān present a somewhat motley picture even in the earliest period. By far the larger portion of the land was inhabited by tribes of Arian race. These, however, did not form a concentrated and united whole, but were divided into hostile parties through differing habits of life and forms of religion.

The upholders of civilization were those Irānian tribes which professed the Mazdian faith. They mostly dwelt in fixed settlements, cultivated the fields, and practised the regular breeding of cattle. By way of exception, the Zoroastrian doctrine seems likewise to have made its way among semi-nomads.

In sharp contrast to the Avesta people stand the bulk of the nomadic tribes of Arian blood. They are mostly comprised under race-names such as Tūra or Dānu, perhaps also Sarima or Sāni. Certain individual tribes are to be understood by the names Driwika, Hyauna, Mardha, Dāha, etc.

At the same time we must admit the possibility that many of these tribes, e.g. the Hunu, belonged to a foreign, possibly the Tatarian, race. That close to the Irānians an aboriginal population not akin to them existed, is beyond a doubt. In the beginning this may have been powerful and numerous. But it gradually became reduced in numbers and withdrew before the victorious Arians into the more inaccessible mountains. The conquered portions became merged in the mass of the victors.

Finally, in the South-East as in the South-West, the Irānians came into contact with foreign nations: in the former with the Indians, in the latter with the Semites. Between them and the Indians of the border provinces continual but unimportant feuds and petty forms of warfare evidently prevailed; but the Semites made themselves hated and feared only by brief occasional campaigns.

# CHAPTER II[1].

## PRIVATE LIFE.

### § 5. *Physical Characteristics of Men and Women.*

. . . . . WE have examined the nation itself as a whole with its division into the believing and the unbelieving, into husbandmen and nomads; we have discussed the opposition in which in Irān the Arians, who had immigrated, stood to an aboriginal population of foreign race. We now return to the narrowest circle and consider the old Irānian as a single individual, the general circumstances of his life, and his position in the house and in the family.

What he was in outward appearance, we cannot easily state. The Avesta offers scarcely anything tangible, as it only touches occasionally upon this question. A comparison with the present descendants of the Avesta people is more profitable.

I will endeavour to delineate the ideal type which seems to have held the mind of the old Irānian. Naturally the reality cannot have invariably corresponded with the type.

In man the principal stress is laid upon bodily strength and health. Zarathushtra therefore prays for these to Verthraghna, the genius of victorious battle, whom fancy naturally endowed with extraordinary strength. They are the gifts for which one also implores Hauma, the *yazata*, who keeps away sickness and death[2].

Wide chest, broad hips, high feet, and above all a clear sharp eye, are the glory of man. These are the attributes which distinguish the king who is to surpass his people

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[1] Ch. iv, § 27, *Ostīrānische Kultur.*

[2] Yt. XIV, 29: *bāzvāo · aojō, tanvō · vīspayāo · dravatātem, tanvō · vīspayāo · vazdvare.*—Ys. IX, 19.

not only by higher intelligence but also in bodily vigour and beauty[1].

The descriptions of the divine beings may also be made use of, as they are certainly [*metaphorically*] spoken of as men perfectly well-formed. The Amesha Spenta, the highest spirits next to Ahura Mazda, are represented as 'endowed with sharp eyes.' The *manes*, the Fravashis, are called 'clear-sighted,' and the star Tishtrya-Sirius 'sharp-eyed[2].' These epithets sufficiently prove the importance which the Irānian attached to the shining brightness of the eye.

Tall in stature, slender in form, strong, able, clear-eyed, having small heels, long arms and handsome calves; all these are in the Avesta honourable epithets for *yazatas* and men[3].

In woman, beauty and elegance of figure are most conspicuous. Symmetry of shape, a slender waist and large full eyes, which are still admired at the present day in Irānian women, are esteemed as the principal of maidenly beauties. Other feminine graces are light complexion, especially about the arms, small slender fingers and a well-formed bosom[4].

It is remarkable that the fifteenth year of a man's life is esteemed as his ideal age, which is regarded as the period during which he who is still in the freshness of youth approaches the work and miseries of life, not with a weak body but in full vigour, the time when the youth comes to

[1] *Perethu-vara, perethu-sraoni, berezi-pādha, anakhrūidha-dōithra*, Yt. XV, 54.

[2] *Verezi-dōithra*, Ys. XXVI, 3; *verezi-chashman*, Yt. XIII, 29; *drvō-chashman*, Yt. VIII, 12.

[3] *Berezat, huraodha, amavat, hunairyach, spiti-dōithra, kasupāshna, dareghō-bāzu, hvaschva*, Yt. VIII, 14; XIV, 17; XVII, 22, &c.

[4] Comp. the epithets *huraodha, urvaęzō-maidhya, vouru-dōithra*; Vsp. II, 7: *ghenāo · hubaghāo, hufedhrīsh, huraodhāoghō*, 'the lovely women of good family (elsewhere *āzāta*), the well-grown up.' *Vide* Yt. V, 127, *yathacha · hukerepta · fsh*tāna · *aghen · yathacha · aghen , navāzāna* (= N.P. *nuvāzān*, 'the lovely, charming, alluring').

the age of puberty[1]. As youths of fifteen, men wandered on earth in the golden age during the reign of Yima, the father like the son. In like youthfulness also appears Verthraghna, the genius of victory[2].

Bodily development ought to be very rapid when such an early age is esteemed the most beautiful one, and this fact stands in the closest connection with climatic circumstances. What we know of the Persians of the present day accords with the above statement. Youths as a rule attain to puberty in their fourteenth year, and are in the habit of marrying shortly after. In old Irān these circumstances must have been quite the same, and the youth was already in full manhood at an age in which, in colder latitudes, he has scarcely passed the age of boyhood.

The statements of the Avesta respecting the exterior in the old Irānian, are, as we see, of a very general kind, and as deficient as insignificant. On just the most important and most decisive points, such as the colour of the hair, the structure of the skull, and the size of the men's beards, we know nothing. It is therefore necessary to supplement the incomplete description of the Avesta by a study of the present descendants of the old Irānian nation. Important to us is the description of the Eastern Irānians, which I have already given above. By means of the same we may perhaps more or less correctly describe the external appearance of the old Irānians in the following manner[3]:

The men were of middle, often of high stature, and were strong-built, with broad and well-developed chests. With the girls and women the general tendency was towards a slender and supple formation of body, the colour of their skin was brighter and more delicate, particularly on those parts of the body which were protected from the influence of the sun. Large shining eyes distinguished both men

[1] 'At the age (*ayu*) in which man first grows up to manhood, first comes to strength, first attains to puberty.' Yt VIII, 14.

[2] Ys. IX, 5; Yt. XIV, 17; comp. also Yt. XXII, 9.

[3] Comp. Ch. I, § 1, pp. 6–7.

and women. The beards of the men were of luxuriant growth. The majority of the people had probably dark-brown hair; but light brown and red hair were not uncommon. Both types, the dark and the light, are generally to be distinguished among the Arians. The brachycephalous structure of the skull was general, the form of the face was oval; nose, mouth, and forehead, and even the extremities, hands and feet, were well-shaped.

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### 6. *Dwelling, Clothing, and Food.*

THE general circumstances of life in which the old Irānian people lived were throughout plain and simple, so far as we can learn from the Avesta. Here we observe nothing of that luxury which prevailed later on in the courts of great Persian kings and in the palaces of Persian nobles. The Avesta people consisted of herdsmen and peasants, and the richest amongst them were distinguished from the humbler and less important class only by their larger estates and herds. Money, the first requisite of commerce, even of the rudest kind, was unknown; cattle formed the means of barter and payment. No mention is made of the importation of foreign goods. The natural products which the Avesta mentions are without exception indigenous.

The soil of Irān itself was poor, yielding only scanty crops, a fact which rendered sloth impossible and enforced diligence, perseverance, and thrift. The chief sources of luxury, fruitfulness of soil, and extensive mercantile intercourse, were consequently denied to the Avesta people, and the conditions of a simple, frugal and unostentatious life were alone known to them.

Hence we can say that the wants of the Avesta people, in reference to dwelling, dress, and food, hardly went beyond the necessaries of life. Compared with the things which were necessary and useful for human life, everything

that tended to its embellishment and refinement was of subordinate importance.

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## § 7. *Birth, Education, and Admission into the Community.*

We now trace the career of the old Irānian during the years of his youth, from his birth to the solemn act by which he was admitted, as a duly recognized member, into the Zoroastrian community.

'The desire for progeny' (*puthrō-ī*sh*tī*) is the motive for marriage-conclusion[1]. If a marriage proves childless, the real object has been frustrated. It was regarded as evidently a divine visitation. Childlessness is a curse, which the yazatas inflict upon those who sin against them:

> 'Hauma accurses him who shall drink it: "Childless shalt thou become and infected with ill-repute, thou who withholdest my juice like a profligate thief[2]."'

Posterity is a gracious favour bestowed by Heaven as a reward for virtuous behaviour and piety. 'The blissful holy Fravashis, the *manes*, grant bodily offspring to those who do not violate agreements.'[3] It is particularly Mithra who blesses with children. Hence he is called *puthrō-dāo*, 'the bestower of sons.'[4] He allows the progeny of his adorers

[1] Vd. III, 33. [2] Ys. XI, 3; Geldner, *Metrik*, § 116.

[3] Yt X, 3. [Rather those who do not violate the sacred bonds of marriage. It is indeed a fact worthy of notice in the sacred lore of the Avesta nation that even the Fravashis, of the departed adherents of the religion of Zarathushtra, bear ancestral love and good-will towards their survivors on earth after their exit from this world. *Tr.*]

[4] Yt. X, 65. [Mithra, the *yazata* presiding over love and friendship or love itself, blesses faithful wives and husbands with offspring, i. e. those who duly observe the holy ties of wedlock. The violation of such ties, it is said metaphorically, brings misery and misfortune upon the family. *Tr.*]

to increase and prosper, while he annihilates the offspring of those who transgress his commands and excite his displeasure:—

'Blood-stained are the settlements, the abodes deprived of their offspring, in which promise-breakers dwell.'

'Who will revere me, who will deceive me, who will hold me worthy of veneration with good or evil sacrifices? On whom shall I bestow wealth and fortune, to whom shall I give health of body, I who am able to do so? To whom shall I grant blissful plenty, I who am able to do so? To whom shall I grant the happiness of bodily offspring? To whom shall I send sickness and death, to whom want and misery, I who am able to do so? Whose bodily offspring shall I destroy at one stroke?'[1]

Naturally it is for sons especially that the yazatas are invoked. Daughters are certainly less desirable. Moreover sons are also the proper defenders of the house. They must guard it from enemies and adversaries, they must stand round their father when he goes into battle, they must propagate his race and improve and increase his estates.

The greater the number of sons the better secured was the stability of the house and of the family. 'Which is, secondly, the place where the earth is most delightful? Where a pious man builds a house in which there are fire, cattle, women, *sons*, and menials. Henceforth also shall there be in that house abundance of cattle, bread and fodder, dogs, women and children, and every enjoyment of life[2].'

When the Irānian prays for wealth in men (*vīryãm-ishãm*) and numbers of men[3] (*vīryãm-vãthwãm*), he

[1] Yt. X, 38, 108, 110. Comp. Geldner, *Metrik*, § 127.

[2] Vd III, 2, 3; comp. *ZddmG.* vol. xxxiv, p. 416. Here '*asha*' cannot possibly mean 'piety.' From the context and from a comparison of Vd. V, 52 where '*yaomcha·ashem*' occurs, I infer the meaning to be 'bread' or 'food.' The Greek word ἀρτός need hardly be referred to. Comp. also Hubschmann, *ZddmG.* 1884. p. 428.

[3] Yt. VIII, 15; comp. also Vd. XVIII, 27: 'Thee shall follow herds of cattle and a multitude of heroes.'

certainly and particularly means brave sons who offer him the best guarantee for the perpetuation and prosperity of his family. Therein concentrating all his wishes, he addresses himself to the genius of fire[1], that forms the centre of all family life, with the words: 'Give me bodily offspring who may found habitations, who may gather around me, who may grow up strong to be a protection in danger, consisting of heroes, who will promote the welfare of my house!'[2]

Hence it is an occasion of joy in the house of the Mazdayasna, when the wife has conceived[3], and a child is hoped for. At this time the woman requires more than ever heavenly protection, that her offspring may be unharmed, and herself propitiously delivered. For this reason she appeals by means of her prayers to Hauma, and still more to the special tutelary *yazata* of the female sex, Ardvi-sūra Anāhita The former protects women at the time of delivery, and bestows on them brave sons and pious children[4]. Of Anāhita it is said in the hymns addressed to her, that she aids the generation of men and prepares all women for childbirth, that she helps all women towards a happy delivery and bestows on them sufficient and well-timed milk[5].

During pregnancy, and even for some time after delivery, women should hold aloof from conjugal intercourse[6]. The tenth month was the normal time for confinement.

The first ceremony performed on a new-born child,

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[1] [As it is a religious custom amongst the Zarathushtrians to invoke the blessing and help of the Deity and other spiritual genii, with their faces turned towards the sacred fire (be it the hearth-fire or that of the sacred altar), so also here the adorer, asking for heroic sons of the above description, prays to Ahuramazda indirectly through the hearth-fire which he regards as the emblem of God. *Tr.*]

[2] Ys. LXII, 5; comp. Yt. XIII, 134; XIX, 75.

[3] *Aputhra*=*ā*+*puthra*; Geldner, *Kuhns Zeitschrift*, XXV, p. 193, note 3.

[4] Ys. IX, 22: *Haomô* · *āzīzanāitibī*sh * *dadhāiti* · *khshaętō-puthrīm* * *uta* · *ashava-frazaiñtīm.*

[5] Yt. V, 2.

[6] Vd. XV, 8

appears to have been the washing of its hands[1]. The fundamental idea involved in this symbolical treatment is that the impurity which is contracted by conception, and which communicates itself also to the child, must be washed off with the purifying element of water. This clearly explains why a woman after confinement is for some time looked upon as unclean.

The antiquity of this custom is proved by quite similar ceremonies among the Indians, who were accustomed to wash a child on the eighth day after its birth; nay more, it is even proved by those practised among the old Germans[2].

The birth of a son was celebrated as a festival in the family of a Mazdayasna. Such old customs are retained in our own time among the Mahomedan Tājiks, in Kohistān, in whom we can safely recognize the remnants of the old Arian population[3]. Among them the parents prepare a feast when a child comes into this world. The mother keeps her bed for five or six days, and a week after the child receives its name in the presence of the Mullān.

With respect to the giving of names amongst the Avesta nation and the ceremonies usually connected therewith, we

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[1] Vd. XVI, 7: *Yezi · aperenāyūkō · frāshnavāt · zasta · hē · paoirīm · frasnādhayen · aetahę̄ · yat · aperenāyūkahē*, 'when the child comes into appearance (is born), they shall wash first the hands of it, viz., the child.' [Here we differ from the author's meaning and would render the passage thus: 'If a child should touch her, they should first of all wash both the hands of it, (that is) of the child.' Here the context plainly shows that we have to do not only with a woman who has just been delivered but one who is in her courses, and consequently the question does not refer only to a child just born but to any child that is supposed to have become unclean by coming in contact with its mother The precept of the Vendidād, therefore, refers to the first washing of the hands of any child that has touched a menstruating woman. *Tr.*]

[2] Zimmer, *AiL.* 320–321; Weinhold, *Altnordisches Leben*, p. 262.

[3] Ujfalvy, *Expéd. scient.* i, p 15. Upon the birthday festival among the Western Irānians, *vide* Duncker, *GdA.* iv, pp. 164–165; Spiegel, *E. A.* vol. iii, p. 706.

know nothing at present. Among the modern Parsees it certainly takes place under solemn formalities[1].

The mother suckled her child at her own breast; the father's duty was chiefly to preserve it from every danger. Both the parents together sought by offerings and prayers to the divine beings to induce them to take the child under their special protection, and to allow it to grow and thrive in strength and happiness[2].

As to the child's education, their first aim was to make of him an able and useful member of their community, and to implant in him those virtues for which the old Irānian people were principally remarkable, and which the Avesta sums up in the words: 'piety in thought, word and action.'

It is pretty clear that the special training of boys for future callings went hand in hand with their religious education, and that it was chiefly regulated according to the profession of the father. The warrior would have his son instructed in the handling of weapons, and the use of the bow, the lance and the sword. The peasant took his children out with him to the field and showed them how to manage the plough, to scatter seed, or gather in corn. Lastly, the priest initiated his sons in the understanding of the Holy Scriptures and their commandments, and fostered in them the consciousness of the sanctity and dignity of their peculiar position.

As even now the *vis inertiae* is a great factor in the choice of a profession, how much more powerful must it have been before the existence of that universal intercourse which destroys all class-distinctions.

[1] Dossabhoy Framjee, 'The Parsees,' pp. 64–65; Spiegel, *E A.* vol. iii, p. 700. [No formalities to my knowledge are generally observed by us at the present day. By the by, it may be said that the initiation into the historical knowledge of our ancestors has led to one social reform, viz., that the mother is not so much inclined to name her child after the manner of Hindoos, as to call it by one of the glorious names of her heroic ancestors. Now-a-days, I believe there are more *Rustams*, *Jehangirs*, and *Shirins* than there were thirty years back. *Tr.*]

[2] This is evident from the idea contained in Vd. III, 31, upon which compare my remarks in *ZddmG.* vol. xxxiv, p. 423.

It was evidently also no uncommon practice to commit children to the care of a priest for training and instruction in the same manner as the Indian Brahmins were wont to do. This practice must certainly have prevailed most among those who were destined for ecclesiastical functions, and the most essential subject of instruction was of course the interpretation of the Holy Text, the right performance of ceremonies, and the ritual of sacrifice. The relation between these teachers and their pupils is not often mentioned in the Avesta, yet we see that it was one of love and friendship[1].

Youths or maidens were solemnly admitted into the Zoroastrian community by investing them with the sacred string[2]. . . . The girdle is the symbol of the spiritual tie which binds together the whole Zoroastrian community. Men as well as women were wont to wear it continually. . . . The modern Parsees call it *kosti*. The *kosti* is a woollen string consisting of seventy-two threads, the manufacture of which is accompanied by certain ceremonies. The season of investiture is now earlier than it used to be in ancient times[3]. In other respects the ideas of the present Parsees with reference to the object and importance of the *kosti* correspond, so far as we know, with those of the Avesta.

From the religious point of view, investiture with the sacred girdle may be compared with confirmation in the Christian Churches, and, from the legal point of view, with a declaration of majority, i.e. with the coming of age. Whoever wore the *kosti* belonged to the adult members of the community and was entitled to all its privileges. He was then relieved from parental discipline, and naturally took upon himself, with his personal independence, also the entire moral and civil responsibility of all his actions, which the parents had hitherto borne wholly or in part.

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[1] Yt. X, 116. The pupil is called *hāvishta* or *aethrya*, the teacher *aethrapaiti*.

[2] *Aiwyāoghana*, 'girdle.'

[3] Dossabhoy Framjee, 'The Parsees,' p. 67; Spiegel, *E.A.* vol. iii, pp. 700–701.

The religious importance of this act is evidently far more interesting to the composers of the Parsee Scriptures than its civil aspect. Nevertheless we assume that the youth was admitted by this act, not only into the religious community of the Zoroastrians, but also at the same time into the army and to new family ties, and was regarded as capable of bearing arms and qualified to vote. Henceforth he was entitled to bear arms and to take a part in the meetings and councils of the village community, he could acquire landed property and manage his own domestic concerns; in short, he became a perfect citizen of the state.

Of the ceremonies accompanying the investiture with the *kosti* nothing is mentioned in the Avesta; however, we know that this custom is very ancient, in no way invented or first introduced by the Avesta people, but only developed and modified to suit their particular ideas.

Amongst the Indians the so-called '*conveyance*'[1] corresponds with it. By this the sons of the three higher castes were entrusted to the care of a Brahmin teacher when they had attained a certain age. Like the Irānian youths they were invested with a sacred string, and the ceremony took place under solemn consecrations and prayers. Here also this act originally marked the admission of boys and youths to the right of contracting family ties. In the Brahmanical period, however, the holy thread became the distinguishing badge of the *dvija*, 'the twice-born,' and the investiture itself was regarded as the sacred new-birth which distinguished the three higher castes from the Sudras, and was considered as the badge of their higher enlightenment.

[1] *Upanayana* (*B. R.* s. v.); Manu, II, 36; *vide* Deslongchamps, *Loi de Manu traduite*, 33, note 1; Spiegel, *E. A.* vol. iii, p. 136.

## § 8. *Love and Marriage.*

THE fifteenth year of age was the normal time of marriage for girls[1].

As the raising of children was considered a duty and their acquisition a blessing, it was naturally wrong and monstrous if a woman did not fulfil her vocation[2]. Besides, it was deemed a grievous sin forcibly to hinder a maiden from contracting marriage:—

> 'For her third complaint mourns the good *Ashi*, the sublime: "That is the worst deed which hostile men commit, when they keep a maiden from marriage and immure her as an unmarried one[3]."'

Hence, no doubt, it was considered a matter of course, as it is still in Persia[4], that a girl should be married on reaching the years of puberty. A young woman who lost her bloom and grew old unmarried, was merely a useless burden in the house of her parents. It even seems that she was frequently subject to taunts and mortification, at all events to general disrespect.

For this reason the thoughts and aspirations of the young daughter of a Mazdayasna were directed towards obtaining a lord and husband, who would take her to his own house; and this most heart-felt of all wishes is expressed with simple candour.

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[1] Vd. XIV, 15.

[2] The tract *Shāyast-la-Shāyast* says: 'The rule is this, that a man, when he does not wed a wife, does not become worthy of death; but when a woman does not wed a husband it amounts to a sin worthy of death; because for a woman there is no offspring except by intercourse with men, and no lineage proceeds from her; but for a man without a wife, when he shall recite the Avesta as it is mentioned in the Vendidād, there may be a lineage which proceeds onwards to the future existence.' West, 'Pahlavi Texts,' part I, pp. 322–323; comp. Vd. XVIII, 51.

[3] Yt. XVII, 59.

[4] Polak, *Persien*, vol. i, p. 205.

Loud and silent prayers arise to the *yazatas*, especially to Ardvi-sūra, of whom it is said. 'Thee, maidens, when they are fit for marriage, implore for strong men and valiant husbands[1].' But the *yazata* of wind, Vayu, who otherwise usually has nothing to do with such matters, is also invoked:

> 'Grant us this grace, that we may obtain a husband, a youthful one, one of surpassing beauty, who may procure us sustenance as long as we have to live with each other, and who will beget us offspring;—[a wise, learned, ready-tongued husband[2]].'

In extreme cases Hauma also is a helper in need, and 'grants to the maidens, who have long remained unmarried, an able, wise husband, who quickly courts them[3].'

The *courting*, or, as it is strictly translated, the *solicitation*[4] for the hand of a maiden, was made to those persons under whose care she stood, that is, above all, to the parents or their representatives. Sometimes, however, women appear to have been independent, and to have been thus able to dispose of themselves as they chose[5].

Whether the motive for marriage was at times real love, or merely the natural impulse and wish for a home, we can hardly ascertain. However, it would be better not to judge merely from modern ideas and views of so old a period and of the peculiar sphere of the East. If the marriage of a grown-up daughter with an orthodox husband may be reckoned as a merit to the Mazdayasna, if it may even

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[1] Yt. V, 87 For a surely very doubtful attempt at interpreting this extremely difficult passage *vide Handbuch*, p. 132.

[2] Yt. XV, 40. This passage is evidently corrupt. The correction *yavānem · sraeshto-kehrpem* for *yavāna · sraeshta* (var. ō) *kehrpa* can scarcely be avoided. Similarly I read *huberetīm* instead of *huberetãm*.

[3] Ys. IX, 23. Unmarried women are called *aghru*, which has naturally nothing to do with rt. *garew*, as I have wrongly taken it in my *Hdb. Glossar.* s. v.

[4] *Jadh* in *moshu-jaidhyamna.*

[5] So at least according to Vd. XV, 9, if here *stātō-ratu* and *astātō-ratu* may be translated by 'standing under the care of any one' and 'not standing under the care of any one.'

be prescribed to him as a penance for certain transgressions[1], such marriage assumes indeed the character of a purely business-like transaction, in which the sentiments and feelings of the persons most interested are generally not taken into account.

Contrasted with the foregoing, a stanza in the *Gāthās*, if rightly interpreted, appears to contain a higher and purer idea of marriage, and to regard it as an intimate union founded on love and piety. On the occasion of the celebration of a marriage, the priestly Singer addresses, as I would believe, the young people, with these words·

*Sāqēnī · vazyamnābyō · kainibyō · mraomī ·*
*Khshmaibyāchā · vaedemnō · meñchā · ī · māzdazdūm ·*
*Vaēdōdūm · Daēnābish · abyaschā · ahūm · yē · vaghēush · managhō ·*
*Ashā · vē · anyō · ainīm · vīvaghatū · tat · zī · hōi · hushēnem · aghat.*

'Admonishing words I say unto the maidens, who will enter into marriage,
And to you (the youth) I, who know it; take them to heart;
Learn to know, through Religion and of these (the parents?), the life of a good mind;
In piety you shall both seek to win the love of each other, only thus will it lead you to joy!'[2]

The courtship was followed by the *betrothal*, through which the girl was entrusted to the man[3]. Between the betrothal and the nuptials some further time elapsed. Among the Gebers in Kirmān, a girl is betrothed at the

[1] Vd. XIV, 15.

[2] Ys. LIII, 5. In stanza 2, of Gāthā, 64, Bartholomä reads *vaẹdemanō* instead of the certainly much better verified *vademanō*. If we accept the last reading, this stanza would be appropriate in the mouth of the bridegroom. Touching this I refer also to the Pahlavî translation which must have likewise read *vaẹdemanō*, for it renders the word by *ākāsīh*. I identify *vīvaghatū* with Skr. *vivās*

[3] Thus *paradhāta* and *aparadhāta* (Vd. XV, 9), 'betrothed' and 'unbetrothed,' come from rt. *dā* with *para*. Also in Skr. *parā-dā*, 'to give up, to surrender,' is mentioned.

age of nine, and married at thirteen. With the Parsees of India the betrothal takes place still earlier. The marriage ceremony consists in joining the hands of a young man and woman, while prayers and holy formulas are recited[1]. Through the touching of their hands the union is made a legal compact.

Of a similar kind were most likely the holy rites which were observed at the *conclusion of a marriage* (*nāirithwana*)[2]. Therewith, the bride, magnificently adorned[3], was conveyed, under various solemn customs and observances, from the house of her parents to that of her husband, which was to become henceforth her new home. Hence the Irānian speaks of a 'taking home' of the wife[4], just as the Greek does of the *ἄγεσθαι γυναῖκα* and the Roman of a *ducere puellam in matrimonium*[5].

It is characteristic, as bearing upon the legal and moral position of the wife in the old Irānian house, that she bears from the marriage-day the title of *nmānō-pathni*, 'the mistress of the house,' just as the husband is called *nmānō-paiti*, 'the master of the house[6].' The wife ranks thus more as the equal of the husband than his dependent. She is not his slave but his companion, entitled to all his privileges, sharing with him the direction and management of the household.

Whilst the man has chiefly to procure through the labour of his hands the necessary means of maintenance for his

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[1] Dossabhoy Framjee, 'The Parsees,' p. 76; Spiegel. *Av üb* vol. ii, p xxviii seq, *E. A.* vol iii, p. 677.

[2] Vd XIV, 15.

[3] Comp p. 226 of *Ostīrānische Kultur*.

[4] *Vadh*, 'to lead.' This verb itself has disappeared from old Indian, and it is only preserved in its derivative *vadhū*, which has no connection with *vah*. Besides in the Avesta *vaz* is also used to denote 'to marry, to take home (a bride).'

[5] Respecting the marriage customs prevailing amongst the Indians I refer to Zimmer, *AiL.* pp. 312–313; Lefmann, *Geschichte des alten Indiens*, p. 99 seq.

[6] Actually corresponding to the Rv. *gṛhapati* and *gṛhapatnī*. In Vd. XII, 7 *nmānō-paiti* and *nmānō-pathni* are as 'husband' and 'wife.'

family, and therefore moves more out of doors, the wife's sphere of action is indoors. As the cultivation of the field, the chase, and war are incumbent upon him, so does she tend the domestic herd, devoting herself to the care and primary training of her children, and to the preparation of food, and the making of needful clothing and other articles of home manufacture.

We shall therefore not err in conceding to woman in ancient Irān nearly the same social position as that occupied by the wife among the Vedic Indians, the Germans, or the Greeks of the age of Homer. Among all these peoples we meet with the same social relations. It is true the man represents the highest power in his small house-state, and the wife too must be willing and obedient to him like his children and domestics, but she is in no way degraded to the rank of a maid-servant or slave, as was the case in Eastern countries even at a very early period[1].

In the Avesta both sexes appear constantly as possessing equal rights; there is no difference as to their respective importance. Pious men and women are frequently named together. As in this world, so also in the next, they live together, enjoying in common the pleasures of Paradise[2]. Wives are an honour to the house[3]; and the good spirits,

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[1] I give here as an appendix the names of relations occurring in the Avesta: *pitare*=Skr. *pitṛ* 'father,' *mātare*=Skr. *mātṛ* 'mother'; *puthra*=Skr. *putra* 'son,' *dughdhare*=Skr. *duhitṛ* 'daughter'; *nyāka*=N.P. *niyā* (not corresponding to the Indian) 'grandfather,' *nyākē* 'grandmother'; *napāt*=Skr. *napāt* 'grandson,' *napti* 'granddaughter'; *brātuirya*=Skr. *bhrātrvya*, masc. 'uncle,' fem. 'aunt'; *tūirya* 'nephew, niece.' Hence further on we avail ourselves of a circumscription, viz., *tūirya puthra* and *tūirya dughdhare*, *tūirya puthra puthra* and *tūirya dughdhare dughdhare* relations in the fourth and fifth generation. Comp. Vd. XII. Comp. further *hvasura* 'father-in-law'=Skr. *çvaçura*, and *zāmātar* 'son-in-law'=Skr. *jāmātṛ*; *brātare* 'brother'=Skr. *bhrātṛ*, and *hvaghar* 'sister' =Skr. *svasṛ*.

[2] Vd. IX, 42; Ys. XXVI, 8; XXXIX, 2; Yt. XI, 4, &c.

[3] Vd. III, 3.

particularly Ahura Mazda, are represented as being in the company of female yazatas [1].

As in the Vedic antiquity, so also amongst the Avesta people, women took part even in the holy ceremonies and solemn offerings. The ladies of the house who cherish good thoughts, utter good words, and perform good actions, who are obedient and subject to their lords, are invited in the Vispered at the offering ceremony equally with pious and orthodox men [2]. Further on it is said that both wife and husband naturally pray together, with uplifted hands, to Mithra for his protection and support [3]. The following remarkable saying of the Rig-veda is also in accordance with Irānian custom: 'Already from olden time the wife has attended the common sacrificial offerings and festive gatherings, she, the fosterer of the holy law [4].'

The first and strictest demand which the bridegroom made of the bride was, that her name and reputation should be pure and unspotted [5], and her virginity before marriage unstained [6]. This demand is enforced with unrelenting severity among the Persians of the present day, though their morality is rather lax. The simple accusation of the husband is sufficient to divorce a young wife and to expose her to misery and shame [7]. This peculiar destiny

[1] Ys. XXXVIII, 1.

[2] Vsp. III, 3, *yavānem · humanaghem · huvachaghem · hushkyaothnem · hudaenem · āstāya . . . nmānahē · nmānō-pathnīm · āstāya, nāirikāmcha · āstāya · frāyō-humatām · frāyō-hūkhtām · frāyō-huvarshtām · hushhām-sāstām · ratu-khshathrām.*

[3] Yt. X, 84. Very obscure and doubtful The word translated by me by 'both wife and husband' is *pithē*. Cf. Spiegel, *Commentar*, vol. ii, pp. 566–567; C. de Harlez, *Av. tr.* vol. ii, p. 236.

[4] Rv. X, 86, 10; Zimmer, *AiL.* pp. 316–317.

[5] *Nāmēnī* (Vd. XIV, 15) is certainly correctly translated by de Harlez by 'elle doit être de bonne réputation' (she has to be of good reputation).

[6] Vd. XIV, 15, *anupaēta* and *askeñda*, the former from root *i* with *upa* (also Skr. *upa-i* means *coire cum femina*), the latter is supposed to be connected according to Geldner (*K.Z.* vol. xxv, p. 211, note 1) with Skr. *skanda*, 'profusio seminis.'

[7] Polak, *Persien*, vol. i, p. 213.

of women, which naturally paves the way for the most shameful abuses, has at least this one advantage that offences against morality are very rare amongst unmarried girls in Persia.

Marriage between blood-relations was forbidden among the old Indians. They exhibit even a religious dread of consanguinity in marriage. As to the Rig-veda, this idea is clearly demonstrated by a remarkable song already often quoted, which contains a dialogue between Yama and his sister Yamī[1]. Here the latter tries to decoy her brother into love, but she is rejected by him with an express appeal to the gods who had forbidden such sin.

How entirely different is the case in the Avesta! Here the marriage of relations is not only unforbidden but even recommended, and described as a meritorious and pious action. It is esteemed as an institution that has proceeded from Mazda and Zarathushtra, and is thus sanctioned as a very ancient custom and a divine ordinance[2]

[1] Rv. X, 10, Zimmer, *AiL.* p. 323.

[2] The technical expression is *hvaetvadatha*, comp. particularly Ys XII, 9; Vsp. III, 3. [We understand the passage (Ys XII, 9) quite differently. Here *hvaetvadathăm* is to be taken as a noun used adjectively and qualifying *Daenăm*. *Āstuye* · *Daenăm* · *Māzdayasnīm* · *fraspāyō-khedhrăm* · *nidhă-snaithishem* · *hvaetvadathăm* · *ashaonīm* · 'I extol the Mazda-worshipping Religion (i. e. the Religion that commands its followers to adore the Wisdom of the Creator), that is far from all doubt, that levels all arguments (disputes), the sacred one which is itself a tie that unites (the spiritual man with God).' Here *hvaętvadathăm*, we believe, does not properly refer to marriage among mankind, as Dr. Spiegel and others have endeavoured to interpret it, but it rather signifies that the Religion revealed to Zarathushtra by Ahura Mazda is the only medium on earth, the sincere belief in which infallibly conduces so to exalt the human mind as to bring it to a clear conception of the Deity. Whatever might be the view of the later Pahlavi writers with regard to the word *khvetudas*, we have no single instance in the Avesta which can suggest the idea that amongst the Avesta nation there ever was a marriage contracted between brother and sister. See the question fully examined by Dr. West, 'Pahlavi Texts,' part ii, Appendix.—*Tr.*]

Later writers also of the traditional Parsee literature frequently expatiate upon kindred-marriages. The *Bahman Yasht* plainly puts the following words into the mouth of Ahura Mazda: 'The most perfectly righteous of the righteous is he who remains in the good religion of the Mazdayasnãn, and continues the religious practice of kindred-marriage in his family;' and, according to the *Shãyast-la-shãyast*, such a marriage is in itself capable of expiating mortal or heinous sins, and serves as an efficient and powerful weapon against the evil spirit Ahriman[1]

It is frequently observed that the Avesta people set a high value on the preservation of the purity of their blood, and stood in great fear of its intermixture with foreign elements. This principle was followed to the utmost extreme in the introduction of marriage among relations . . . .

Among modern Persians kindred-marriage is not rare. It is here evidently a remnant of antiquity which has been preserved to the present day, with the tenacity peculiar to such family institutions, in spite of the entirely altered circumstances under which they now live. Besides, this custom, as we learn from well-informed judges, is by no means attended with results disastrous to the children[2].

In conclusion, I come to the question whether monogamy or polygamy existed amongst the Avesta people.

I premise that the bare principle only is here to be treated of, and not its practical application. Persons in poor and embarrassed circumstances, who were not in a position to support several wives and a larger number of children, were perforce obliged to be content with *one* wife. We must absolutely set aside the question concerning concubines or persons who lived in a state of concubinage. Polygamy properly so called is only spoken of where several women occupy towards one man the same lawful

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[1] *Bahman Yasht*, chap. ii, p. 61; *Sh.-lā-sh.* VIII, 18; XVIII, 3. *Vide* West, 'Pahlavi Texts,' part i, pp. 213, 307, 387.

[2] Polak, *Persien*, vol. i, pp. 200–201.

rank, and where the children of all of them are considered to have been begotten in lawful wedlock.

Unfortunately in the Avesta there is a lack of positive testimony as much concerning the one (monogamy) as concerning the other (polygamy), and we must therefore content ourselves with merely indirect proofs and conclusions drawn from analogy.

Sons and wives are esteemed as an ornament to a house, and the *yazatas* bestow them upon the pious in abundance. This might be construed as an indication that polygamy was customary and a great number of women a mark of opulence and divine blessing[1] . . . .

However, it would be better not to lay too much stress upon such isolated passages of almost universal import, nor to draw from them any far-fetched conclusions.

The Parsees of India live, as we know, in monogamy. But that is in no way an original custom. A short time ago bigamy was in general use[2]. So too we learn of the Tājiks living in the mountains of Zerafshān that with them polygamy is indeed not the rule but is by no means forbidden[3].

The modern Persians and their marriage customs may therefore be used for comparison only with great reserve, since they naturally come under the influence of Islāmism. But amongst the old Persians polygamy was commonly practised . . . .

I shall go even further. Among the old Indians, also, it

[1] [The passage wherein the Avesta esteems 'sons and wives as an ornament to a family,' does not imply the wives of a single man but all the married women living in the same house. Just as is the case now in Parsee families, so also in the age of the Avesta may we conceive a Zoroastrian family as having married daughters, daughters-in-law, and even granddaughters-in-law with the *materfamilias* at their head, all forming a group of more than a dozen women. Even when the Zoroastrian prays for sons, he does not generally pray for sons only but for sons and wives, i. e. sons who should be sufficiently well settled in life to afford to marry as well as to maintain households of their own. *Tr.*]

[2] Dossabhoy Framjee, 'The Parsees,' p. 88 seq.

[3] Ujfalvy, *Expéd. scient.* i, p. 16.

is supposed on the authority of some passages of the Rig-veda, and indeed evidently with full justice, that at least men of rank frequently enjoyed a plurality of wives[1]. There is likewise no doubt that in ancient Germany, particularly in the case of princes and grandees, polygamy was an old and primitive custom which was only in course of time replaced by monogamy[2].

We have here numerous analogies and grounds of probability which appear to speak in favour of the antiquity and priority of the custom of polygamy. In support of any contradictory opinion I have nothing to bring forward.

Under such circumstances I consider it almost certain that plurality of wives was not prohibited to the Avesta nation. Probably every one was free to do as he liked. Whoever was able to maintain more wives and a larger household, could marry several; whoever could not afford it, contented himself with only *one*. The precepts of their religion left this question wholly untouched, because there was no question at all of that custom being allowable or not allowable, or of its being right or wrong, but simply an accidental or personal ability or inability. In this way the silence of the Avesta is most simply explained. Had the Avesta prescribed monogamy, thus being in conflict with the custom which we know to have prevailed elsewhere in the country of Irān, there would have been certainly no lack of passages which opposed and attacked polygamy, and which represented the new institute of monogamy as sacred and divinely established.

Finally, I must further add that polygamy is not at all against the natural order, and as regards its practice in the Orient it is even explained and justified by the nature of the climate. It is even doubly intelligible in a nation that lays so great a value upon a numerous posterity as is known to have been done by the Avesta people.

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[1] Zimmer, *AiL.* p. 324; Lefmann, *Geschichte des alten Indiens*, p. 98; Kägi, *Der Rig-veda*, XV.

[2] Weinhold, *Altnordisches Leben*, p. 248 seq.

## § 9. *Prayers and Household Customs.*

THE scantiness of our references unfortunately does not allow us to describe, on the basis of the Avesta-text, the daily life of the Zoroastrian, the arrangement of his household, his professional and religious duties and occupations, and the change from labour to relaxation.

We can here only discuss the most important customs and ceremonies which are prescribed to the Mazdayasnãn, men as well as women, as a regular exercise, or to meet certain occasions of daily life.

The whole life of the faithful man was, according to the view of the Avesta, a conflict with the powers of darkness, with Angra Mainyu and his demons. He was threatened on all sides with their persecution. He had to remain ever on his guard lest he should have to yield to the evil power through some transgression. He was however enjoined to extend and strengthen the kingdom of light and to impair and diminish that of darkness, through his active interference in the great struggle between the heavenly and the infernal spirits.

Thus he had to be vigilant, alert, and active. Sloth and laziness induced to vice. Even sleep itself was really a mere concession to the demons[1], and therefore one had to endeavour to limit its power over him as much as possible. As soon as, at early morning, with the break of day, the good spirits had overpowered the demons of night and had begun to exercise their power anew, the pious had also to rise and to go to their daily work. In this they were chiefly assisted by Chanticleer, whose call scared away slumber. It is to this circumstance, I believe, that the domestic cock owes the great attention which is paid to it among the Zoroastrians. I shall dwell upon this more fully in my description of the domestic animals.

In the war against vice the divine beings bring succour to men in various ways. This succour they grant as a

[1] Comp. however Vsp. VII, 3.

mighty weapon through which man can avert and annihilate the destructive influence of the demons[1]. Such is the Holy Word which Mazda has revealed to Zarathushtra; such are the prayers which he has taught him.

The conception of the nature of prayer seems to us rather an extrinsic one. It is not [*always*] the internal elevation of man towards God, nor the degree of devotion and fervency, which makes it efficacious. To the words themselves belongs mysterious, one might almost say magical, power; the mere recitation of them, if correct and faultless, brings that power into action.

These prayers are not to be recited merely on particular occasions; they do not secure help and deliverance in times of imminent danger and difficulty alone. As the demoniacal powers are constantly lurking in ambush to do injury unto men, it is commanded to say prayers, even as a sort of preservative, regularly at fixed hours of the day, and in all constantly-recurring occupations and actions.

For the modern Parsees the precise forms of prayer are strictly laid down; a brief survey of them will be sufficient[2].

On rising, washing, and dressing, especially on tying the sacred string, a series of prayers are to be repeated. Next follows the special morning-prayer. Before and after each meal, likewise, prayers are said; and in the evening, before the Parsee goes to sleep, he has, further, to reflect upon and examine what he has done in the course of the day, and then only, after reciting certain prayers, he retires to rest.

[1] Thus it is said of Zarathushtra that he by means of the prayer *Yathā-ahū - vairyō* frightened away the demons who, having plotted his ruin, had surrounded him (Vd. XIX, 2). Zarathushtra exultingly says further on: '(I will conquer) by means of the (sacred) mortar, and the cup and the *hauma*, and by the prayer (*vacha*) taught to me by Mazda. My weapon is the *Vahishtem-prayer*; with this I will conquer and frighten away the demons. This weapon is an excellent one, O thou profligate Angra Manyu!' Vd. XIX, 9.

[2] Spiegel, *Av. üb.* vol. ii, p. l. seq.

To the prayers, which form part of the order of the day, are further added a number of others which must be said on certain occurrences, viz. after sneezing, after connubial intercourse, after satisfying natural purposes, after pollutions during sleep, after the cutting of nails and hair, as well as after the lighting of candles.

Several of these cases are anticipated in the Avesta[1], and if others are not mentioned, it may be owing perhaps to the incompleteness of the text. Besides these, prayers are naturally also prescribed for the different ceremonies of purification. They should be repeated, according to circumstances, twice, thrice, four times, or even oftener, and must alternate with the recitation of strophes or sayings from the Gāthās[2]. For deceased relations also, and all relatives, near and distant, it is a solemn obligation to say prayers and to recite the sacred hymns[3].

There are, on the whole, four prayers which can be adapted to the most diverse occasions. Three of these are composed in the antique dialect of the Gāthās, the fourth, the prayer *Yeg̃hē-hātãm*, shows the same language as the later Avesta. The prayer *Airyema ishyō* is of subordinate importance, whilst the efficacy of the two others is commended in the Avesta in inspired words. Unfortunately the text is extremely difficult and obscure, so that none of the attempts hitherto made to interpret it can be considered as perfectly satisfactory[4].

The prayer *Ashem vōhū* is translated by Haug in the following manner:—

'Righteousness is the best good;
A blessing it is; a blessing be to him
Who is righteous towards *Asha-vahishta*.'

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[1] Vd. XVIII, 43 and 49; XVII; *vide* Duncker, *GdA*. iv, pp. 158–159.

[2] Vd. VIII, 19; XI and XII; XIX, 22.

[3] Vd. XII.

[4] Spiegel, *Comm.* vol. ii, p. 466 seq.; Haug and West, 'Essays on the Parsis,' p. 141, note 2. The text is found in Bartholomä, *Gāthās*, pp. 65–66. Comp. now also Roth, *ZddmG.* XXXVIII, p. 437.

Its meaning is praised in the Hādokht-Nusk[1]. All that is good and excellent is comprised in it, and all other prayers are, so to say, included in it. But foremost amongst all the forms of prayer is the *Ahuna-varya*, or, as it is called by the Parsees, the *Honover*:

'Just as a heavenly lord is to be chosen,
So is an earthly master for the sake of righteousness,
As a giver of good thoughts, and of the actions of life towards Mazda.
The dominion belongs to the lord whom he has appointed as a protector for the poor.'

Regarding this prayer it is said that Ahura Mazda first uttered it, and that it existed before the heavens, before the water, before the earth, before the animals, the plants, and mankind[2]. One should recite it without any omission, and not intermix it with anything foreign, if it is meant to have its full effect. Whoever recites it in the manner prescribed, his soul crosses over the bridge which separates this world from the next, and reaches the highest paradise, the most brilliant stars.

The *Honover* is the best prayer that ever has been and ever will be spoken. As long as the earth exists it must be recited, and it will protect from death him who says it and who remembers it.

Lastly, it is expressly declared in another passage that this prayer, which had the Highest God for its author, was also recited by the prophet Zarathushtra:

'Renowned in the country of Aryana Vaija hast thou first, O Zarathushtra, said four times the *Ahuna-varya*, dividing it into verses[3].'

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[1] In Westergaard, Yt. XXI, note; Haug and West, 'Essays,' p. 218 seq.

[2] Ys. XIX; Haug and West, 'Essays,' p. 185 seq.

[3] Ys. IX, 14; cf. Haug and West, 'Essays,' p. 179. In my *Handbuch* I have wrongly interpreted the epithet *vīberethwat*; it is certainly derived from root *bar*=Skr. *bhar bhṛṇāti*, N.P. *burīdan*. Comp. also Geldner, *Metrik*, p. 127: 'four times with the transposition of parts.'

Besides prayers, sacrifices and offerings may also be noticed here. But as these were only of a private nature, offered only in the rarest cases, and conducted mostly by priests, they will be discussed hereafter.

On the other hand, I must here mention the tending of the hearth-fire, as this was undoubtedly the daily and constant duty of every master of a house, and consequently belonged to household customs in the proper sense of the word.

With the employment of fire begins the civilization of mankind, and this beneficent element, the use of which, like speech and reason, distinguishes men from beasts, enjoys on that account divine veneration everywhere on our globe. To the Avesta people, however, it is something more than the mere foundation of civilized life. With them it is at the same time the holiest and the purest element, the reflection of their Highest Deity, Ahura Mazda. It is moreover the symbol of moral purity, and a strong weapon of defence against the demons. During night and darkness, when the wicked demons are at their work, fire produces light and brightness, and frightens away these hellish spirits.

Fire is directly called *Ahurahē Mazdāo puthra*[1], 'the son of Ahura Mazda'; he is His earthly image, of the same nature and essence with Himself. He is a genius who, after the creation was completed, first spontaneously descended upon the earth in order to protect the creatures devoted to Mazda against the powers of evil[2]. This is proved by the fact that Asha-vahishta, the genius of 'the best piety,' is at the same time the genius of fire. Hence also the hearth-fire, as the centre of the house, is the symbol of a fixed settlement; and the latter, on the other hand, is the characteristic or token that distinguishes the righteous and faithful from the impious.

The worship of the hearth-fire amongst the Indo-Germans deserves a succinct description. Amongst the

[1] Spiegel, *E. A.* vol. ii, p. 41 seq.

[2] *Vide* Spiegel, *Traditionelle Literatur der Parsen*, p. 332.

Irānians it is called *nmānō-paiti*, 'the master of the house,' amongst the Indians, *gṛhapati* which means the same thing. With the Greeks and Romans also it is the centre of their family-life. Round the ἑστία, the consecrated hearth, assemble the family on the Apaturian and Amphidromian festivals. The *pater-familias* or the *mater-familias* looks after the cult. All libations that are offered begin with the *Hestia*.

Near the hearth of a Roman house stand the images of the Lares and Penates. The marriage-ceremony is performed near it, as was customary among the old Indians. The young couple are received at the entrance into the new house with the fire of its altar. Near the hearth is placed the nuptial couch.

Similarly, in the house of the old German an ever-burning fire blazed on the hearth, as an emblem of the everlasting duration of his family and his race. Round about this fire stood the images of the household gods carved in wood. It was the centre of the family worship. A remnant of this old custom survives still in the sports of children.

The mighty Fire which is useful to the pious in a multitude of ways, but which annihilates the vicious in the form of deadly flashes of lightning, is commended in the Gāthās:

> 'After Thy Fire, O Ahura, the powerful, do we yearn in a pious manner,
> After the swift, mighty, that rejoices the creation, and lends manifold assistance,
> But which, O Mazda, works the destruction of the enemy through the bolts of his hands[1].'

From the smoke and the flame of Fire it was believed that the Will of the Deity could be recognized. His crackling flame was the means whereby He spoke to men. In doubtful cases especially the oracular decision of Fire appears to have been often invoked[2].

The hearth-fire, however, must also be preserved and

[1] Ys. XXXIV, 4.

[2] Ys. XXXI, 3 and 19. Cf. further *infra*.

tended by men. According to a certainly very ancient idea, it must at no time, not even in the night, be extinguished. It must continually blaze and shine as a never-resting champion against demons. When the bright flame becomes extinct, the good spirits, who protect the house from the terrors and dangers of darkness, disappear from it.

The fuel must be dried before it is used[1], in order not to contain any moisture which would cause the two elements, water and fire, to clash. Moreover, the proper kind of wood must be selected, some fragrant species, such as *Hadhānaipata* being most desirable The bark was probably stripped of the wood before burning[2].

The wood must be carried with clean-washed hands, and this is a duty which is to be fulfilled at the beginning, middle, and end of the night, but particularly at early morning when people rise from their beds with the first crowing of the cock. Otherwise *Āzi*, the demon of want and lust, would cause damage to the fire and it might die out from lack of fuel.

Furthermore, Fire actually shows his gratitude to him who bestows due care upon him. As to the master of the house, he blesses him above all things in his domestic life, allows a goodly number of able sons to grow up, and all that belongs to him to improve in power and importance.

> 'May herds of cattle follow thee and men in numbers! May a powerful mind and an active soul follow thee! Mayest thou pass thy life with a merry heart all the days that thou livest!'
>
> 'This is the benediction of Fire unto him who brings him fuel, dry, picked out at daylight, rightly prepared with the intent of the holy commandment[3].'

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[1] Comp. the whole section Vd. XVIII, 18 seq.

[2] Ys. LXII, 10; Vd. VIII, 2; Vd. XVIII, 27 (the stripping of the bark is perhaps meant by *yaozhdāta*). We may compare the statement of Strabo (p. 732), that the Persians offered sacrifice to the fire by laying one over the other pieces of wood without rind. Windischmann, *Zoroastrische Studien*, p. 295. The fuel is called *aęsma*.

[3] Vd. XVIII, 27; cf. also Ys. LXII, 10.

The numerous commandments of purification, which are given by the Avesta for almost all imaginable occurrences, have a direct and important bearing upon the daily life of the Zoroastrian. They are multiplied to such an extent, that the excess of formalities and ceremonies must necessarily choke the deeper sense which underlies them

The Indians, also, look upon a variety of objects as impure, and believe that their impurity may be transferred by contact to men, who have then to remove it by means of prayers, ablutions, and other similar remedies. But this idea is among the Irānians of the Avesta carried to its furthest extreme, and has consequently, as affecting ordinary life, a still greater importance and meaning. The notions of the Brāhmanical Indians and the Eastern Irānians, moreover, exhibit in this respect a striking resemblance even as to details, and, indeed, in such a manner that we have a right to regard them as very ancient, and to trace them at least to certain common fundamental aspects, which have been transmitted to us from Arian antiquity.

In the Avesta, *dead bodies* are pre-eminently considered as impure. However, the logic of this view is very sensible and excellent. Impure are only the corpses of originally good and pure beings, and they are so, indeed, on the ground that the party of light has sustained a loss on account of their death. If, on the contrary, a vicious person dies, it must be regarded as a gain; his dead body cannot therefore exercise any corrupting influence[1].

Thus it is principally the dead bodies of pious human beings and those of particularly holy animals, such as the dog, from which contamination issues. Immediately after

[1] Thus it is said in Vd. V, 36: '*Living* a destructive, evil person, as for example an *ashemaugha*, directly or indirectly causes pollution to the creatures of the blissful spirit, O son of Spitama, Zarathushtra; *living* he smites the water, extinguishes the fire, and carries away the cattle; *living* he inflicts upon the pious man such a wound as robs him of his life or disfigures his body... *but not* [*so when*] *dead*.'

death has taken place, the demon of putrefaction[1] prevails and enters the corpse in the shape of a fly, and therewith the dead body has fallen into the grasp of the evil powers and pollutes whatever comes in contact with it.

The different degrees of pollution are laid down most minutely[2]. The principal distinction is that made between immediate contamination, when one comes into direct contact with the impure object itself, and the indirect pollution which spreads of itself from a defiled person or thing[3].

Not only men, but beasts also, may be polluted; and even utensils, particularly those which are used in religious ceremonies, clothes, etc.

Water is impure when a dead body has been rotting in it, or when it has been poured upon a carcass; the roads upon which corpses are conveyed also become impure, and so do houses in which anybody has died; in fact, any piece of land upon which a dead body has lain.

Above all, the holiest element, fire, was naturally most exposed to defilement, and it had to be therefore preserved with great care, so that it might not come into contact with anything impure. It is always water or fire which must be taken to a safe place when a death or similar occurrence of polluting influence takes place[4].

Even by its employment in daily life, more particularly by its application to industrial purposes, fire became unhallowed, according to the notions of the Avesta. Hence it had to be purified from time to time, and to be brought back to the 'lawful place,' the holy fire-altar of the community, and by fetching thence a fresh brand wherewith to revive the fire of the home-hearth[5].

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[1] *Druj-nasush.*

[2] Comp. Spiegel, *E.A.* vol. iii, p. 693 seq.; *vide* Vd. V, 27 seq. and the remarks in my *Hdb.* pp. 85–86. Duncker, *GdA.* IV, pp. 161–162.

[3] *Hăm-raęthwa* and *paiti-raethwa.*

[4] Comp. Vd. VIII, 73 seq., upon the treatment of the fire with which a corpse was burnt; Vd. V, 39 seq.; XVI, 1 sec

[5] Vd. VIII, 82 seq.

Here also we come across the traces of a very ancient fire-cult. Analogies of the most striking kind to this custom of the Avesta people are to be found among the Greeks and Germans.

In Lemnos, the most holy centre of the worship of Hephæstus, it was a custom annually to extinguish for several days all the fires in the whole island. A sacred ship then brought from the altar at Delos a fire-brand with which fresh hearth-fires were kindled throughout the island amid the loud rejoicings of the people

In Germany also, there existed until modern times in several districts (as in the country of Marburg and in Lower Saxony) the custom, manifestly descended from the heathens of extinguishing now and then all the hearth-fires. By rubbing a piece of wood on a wheel, that is, in the old solemn manner, fresh fire was then kindled, from which everybody ignited his own piece of wood and carried it home[1].

The common fundamental idea of this custom amongst the Irānians, Greeks, and Germans, is that the fire in daily use, communicated from one log to another, must have lost in purity through the service of men in course of time, and had therefore to be restored and renewed by fresh fire, the pure, celestial, and still unpolluted element.

The pollution of men, clothes, implements and such like, had to be removed by washing with water and cow's urine. The latter is regarded also by the Indian as miraculously efficacious, and is frequently prescribed in the code of Manu as a means of purification[2].

Besides such ablutions, rubbing with earth and fumigation are employed. The latter remedy is used, besides the recitation of sacred *măthras* (sayings), for the purification of dwellings[3] . . . . . .

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[1] With this comp. A. Kuhn, *Die Herabkunft des Feuers.*

[2] Manu, V, 59 seq.; for particulars *vide* Duncker, *GdA.* IV, p. 128 seq.

[3] Vd. VIII, 2; XII; IX, 32 and XIX, 24 (with this comp. my *Hdb.* p. 107).

The fire had to be conveyed outside the house polluted by the death of an inmate, and it could only be brought back after the lapse of a month during summer, or of nine days during winter[1].

Defiled land had to lie fallow, defiled water had to be baled out and thrown away. Roads, after a dog had been led over them, had to be reconsecrated by the priest reciting certain prescribed prayers[2].

The purification of vessels was to be repeated the oftener the more valueless the material was of which they were made. Vessels of lead and wood, when even once polluted, remained impure for ever[3].

Nor do only dead bodies cause pollution. According to the view of the Avesta, women after childbirth are likewise unclean. Among the modern Persians the period of forty days is fixed for a woman lying-in, and during that time she must remain apart from her husband. Analogous to this are also the precepts current among the Parsees of Bombay. The woman is brought to the ground-floor of the house before her delivery. After the child is born, she remains in the same place for forty days. It is only after the lapse of this term, and after performing ablutions with cow's urine and water, that she can again associate with other members of her family, and devote herself to her husband[4].

The Mosaic law determines a period of thirty-three days after the birth of a boy, and of sixty-six days after that of a girl, during which time the woman who has been confined is regarded as unclean, and remains within doors[5]....

During their menses also women are impure, and to a certain extent in the power of evil. They are unclean, and impart pollution to objects and persons surrounding them. Consequently they are lodged during that time in a special

[1] Vd. V, 39 seq.

[2] Vd. VI, 1 seq.; VI, 33 seq.; VIII, 14 seq.

[3] Vd. VII, 73 seq.

[4] Polak, *Persien*, i, p. 220; Dossabhoy Framjee, 'The Parsees,' p. 63.

[5] *Leviticus*, XII, 4 seq.

place, where they remain perfectly secluded from all that could be exposed to defilement.

Their place shall be covered up with dry dust, and be cleared of all plants and weeds: it shall be situated higher than the surface of the rest of the house, so that the eye of the woman may not fall on the hearth-fire and defile it. Fifteen steps distant must that place be from the sacred elements, water and fire, as well as from the sacred chattels used in offerings; and only as far as three steps distant can pious men approach it.

Even now in [*a few*] Parsee houses such a resting-place is found for unclean women, which is called *Deshtānistān*. It is an apartment void of every comfort, and from which one can neither perceive the sun, nor the moon, nor the stars, neither fire nor water, nor sacred vessels, much less any men[1].

Three days were regarded as the normal period of menstruation, and the ninth day was its utmost limit. If it continued still longer, it was the work of the demons, an appearance of sickness. Under ordinary circumstances the isolation of the woman continued for four days, and only after fitting ablutions could she return amongst other people[2].

In modern Persia it is enjoined that women should refrain in such cases seven or eight days long from bathing and from holding any intercourse with their husbands. The Mosaic law prescribes a separation of seven days, during which time women are unclean and are forbidden to men[3].

Of course the Avesta likewise forbids men conjugal intercourse with their wives during their courses; the infringement of this prohibition seems to have been at first

[1] West, 'Pahlavi Texts,' part 1, p. 277, note 4. Very detailed statements regarding the treatment of menstruating women are contained in the Tract *Shāyast-lā-Shāyast*, chap. 3.

[2] The statement essentially rests on the beginning of Vd. XVI, where the management of a *nāirika-chithravaiti, dakhshtavaiti, vohunavaiti* is discussed . . .

[3] Polak, *Persien*, i, p. 203; *Lev.* XV, 19.

considered even as an inexpiable sin. Later on a milder view was taken of it, for another penalty, though indeed a very high one, was set upon it. If the guilty one avoided the punishment, he was regarded as one damned, and was abandoned to the infernal powers[1].

A similar rule of conduct as that for menstruating women is also prescribed by the Avesta for such as have miscarried. These must also be lodged in a separate place, furnished with an enclosure, and thirty steps distant from fire, water and sacred utensils; the ground being as dry as possible, and cleared of plants. People must again remain three steps distant from it. During confinement they receive as food first only milk, then fruits, and later on, after the lapse of three days, meat, bread, and *madhu*, but no water[2].

The ceremonies through which impurities were removed were of very different descriptions. Sometimes they consisted in the washing of the head, sometimes in that of the hands and arms, sometimes in that of the entire body[3]. Particular importance was attached to the cleaning of the nine doors or openings of the human body, viz. of the eyes, ears, and nostrils, of the mouth, &c., because through them, so to say, the interior of the human being is connected with the exterior world[4].

In the higher and more unusual cases of pollution the Zoroastrian could not even undertake to perform the ceremony himself, but had to call in a priest. Particular efficacy was held to belong to the so-called *purification of the nine nights*, which Spiegel has fully described on the basis of the

[1] The idea in Vd. XVIII, 67–76 and XVI, 14–16 on the one hand and that in Vd. XVI, 17 on the other seem to contradict each other. We have here probably again to do with two different views of the Vendidad (comp. *ZddmG.* vol. xxxiv, p. 415).

[2] Vd. V, 45; cf. Geldner, *K.Z.* xxv, pp. 209–210.

[3] *Frasnāiti, upasnāiti, usnāiti*, Vd. VIII, 98. Comp. Spiegel, *Av. üb.* vol. ii, p. lxxxv.

[4] Vd. V, 54; cf. Geldner, *K.Z.* xxv, p. 209; Vd. III, 14 (*ZddmG.* vol. xxxiv, p. 419).

statements contained in the ninth chapter of the Vendidad and of the traditional supplements[1]:—

'For such a purification a barren piece of ground is selected, where there is neither water nor tree, and which is distant from fire and from pure beings. Six holes are then dug in the ground, two fingers deep in summer, four fingers deep in winter, each of them a step distant from the other; afterwards three more holes are dug, which are three steps distant from the six before mentioned. Round these holes twelve circles are drawn, in such a way that three circles surround the three holes, three the six holes, three all nine, and lastly three more surround them all. The defiled person stands near the six holes inside the circles, the priest outside of them. After a short prayer is recited by the priest, and repeated by the polluted one, the latter is besprinkled by the purifier with the urine of the bullock, which is first poured into a vessel (commonly a spoon) that is fastened to a stick containing nine knots; in this way the priest can approach the body of the defiled with the spoon, although he himself stands outside the circles. After the polluted person has cleansed his whole body with the urine, the *Ahuna-varya* is recited, and thereupon the uncleanness or, according to the notion of the Irānians, the demon of uncleanness, leaves the man. The person purified then approaches the other five holes, at each of which the priest recites the *Ahuna-varya* anew; near the sixth hole he rubs himself fifteen times with earth, and washes himself afterwards with water near the remaining three holes. After this he has still to wait for nine nights, and to wash himself every third night; then only is he again fit to associate with other people.'

[1] *E.A.* vol. iii, pp. 698–699; (*Av. ub.* vol. ii, p. lxxxv. seq.).

[In connection with the Bareshnūm Ceremony of purification for any Zoroastrian man or woman, it would be very interesting to read Dr. West's elaborate description of the same, given in his 'Pahlavi Texts,' part ii, pp. 431–454. *Tr.*]

## § 10. *Death and Disposal of the Body.*

DEATH is regarded in the Avesta as a separation of the body and the soul[1], as an analysis of the two constituent parts of man, of the perishable matter and the immortal everlasting force which had made her abode in the body during life. The activity of the soul of man manifests itself according to different tendencies and in different spheres. Consequently the Avesta assumes the existence of several faculties of the soul, which, dissimilar in their nature and mode of operation, reside in the human body. We shall later on make it our business to express our thoughts on the Avesta doctrine of the soul. At present it will suffice to prove that the soul and the vital power are not identical; through the decay of the latter the soul is forced to quit the body.

When death takes place, the soul does not at once depart entirely from the body to which it once belonged, but still remains for three days and three nights in its vicinity[2]. Death is, therefore, a kind of transitional stage, during which, however, the soul experiences a foretaste of the fate that awaits it. The soul of the pious man already feels the delights and joys of Paradise, but that of the impious man the anguish and torments of Hell.

The body of the deceased Mazdayasna falls a prey to the powers of evil as soon as the soul has vanished from it; yea its activity has ceased. It can never subdue and impair the kingdom of Angra Manyu. The demons rejoice over its death. From the Northern regions which are considered by the Eastern Irānian to be the abode of every-

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[1] *Astascha · baodhaghascha · vī-urvishti*, Vd. VIII, 81; XIX, 7. Designations for 'body' are, besides *asti*, the rather irregular *azdēbīsh* (?skeleton), *ushtāna* ('form, outward appearance,' comp. Geldner, *K.Z.* xxv, p. 309, note 1), and *kehrp*. Ys. LV, 1.

[2] *Urvan*; this includes the moral and intellectual power of man (*urvan* and *baodhagh*), as well as the guardian spirit (*fravashi*) accompanying it during life. With this description comp. Yt. XXII; next Haug and West, 'Essays,' p. 219 seq.

thing evil—where the waterless, barren deserts extend where the burning winds of summer and the snow-storms of winter blow, where hostile tribes dwell—comes the ghost of the corpse, the frightful DRUJ-NASUSH[1]. It takes possession of the corpse in the shape of a fly, probably because on every corpse are to be seen flies—in themselves loathsome and impure creatures. It has its chief seat in the nose, the eyes, the tongue, the jaw-bones—here by metonymy used for ears,—the sexual organs, the *clunes*,—that is at the doors of the body,—which always appear subject to pollution to a particular extent[2].

From the dead body the impurity spreads itself further in the house in which the corpse lies, and to everything that is in it. It communicates itself to survivors and relations, and does so the more the nearer they have stood in relationship to the dead. There now begin a series of ceremonies, which I have already described, for the purpose of washing away the pollution.

But the most peculiar ceremony, which is performed on the dead body itself before its disposal, is the SAGDĪD. I here confine myself to the most essential points, since this subject has been before fully and frequently treated[3].

The ceremony consists in leading a dog towards the deceased, so that his eyes may fall on the corpse. I may here mention that they ascribe to the glance of a dog the power of scaring away the Evil Being. With the same view evidently a dog is conducted over the way by which a deceased person has been carried, in order to make it again accessible for men and beasts.

The dog to be employed for the *Sagdīd* must have

[1] Vd. VII, 2 [so to say, the wind of putrefaction].

[2] Vd. III, 14; IX, 40. Comp. *supra*, p. 82.

[3] The word comes from N.P. *sag* 'dog' + *dīd* from the infinitive *dīdan*, from rt. *dī* 'to see.' *Vide* the commandments of the Pârsee tradition respecting this custom in *Pahlavi-Vendīdād*, III, 48; and in *Shāyast-la-Shāyast*, II, 1–3 (West, 'Pahlavi Texts,' part i, pp. 245–246); comp. further Spiegel, *Av. üb.* vol. ii, p. xxxii. seq.; ibid. *E.A.* vol. iii, 701 seq.; Dossabhoy Framjee, 'The Parsees,' p. 93 seq.

certain special marks: he must be four-eyed—this I shall explain further on—he must be of a yellow colour or white with yellow ears[1].

A very ancient popular idea lies at the root of this entire custom, the knowledge of which, however, was wholly lost even to the Avesta people[2]. According to the old Indian legend, Yama, the god of death, has two dogs who follow him. They guard the path leading into the next world, and alarm and frighten the souls wandering therein. Or, like a hunter, Yama sends forth the dogs as his messengers, to bring home the souls who have fallen into his power.

In a funeral song of the Rig-veda they call out, therefore, to the deceased:

> 'Run straight past the two dogs of Saramā, the four-eyed, parti-coloured.'

Or the departed ones are recommended to the protection

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[1] *Spānem · zairitem · chathru · chashmem · spaetem · zairi-gaoshem*, Vd. VIII, 16.

[2] [We cannot see how the Avesta people could have been ignorant of this oriental idea regarding the power of the spiritual dogs on the Chinvat Bridge, or of what is already alluded to in the passage (Vd. XIII, 9), where the soul (*urva*) of the deceased person is represented as being (on the morning of the fourth day after death) accompanied by his conscience (*daęna*, i. e. the consciousness of his own good or bad actions), together with the two spiritual dogs (i. e. spiritual confidence and watchfulness over one's self), called in the Avesta *peshu-pāna*, or '(the dogs) that guard the bridge.' Their work is to preserve the soul, during its passage, from any evil influence of the hellish fiends (probably distrust in one's own moral behaviour), which are supposed to be haunting the Bridge of Judgment in order to drag away the pious soul into hell. We would rather presume that the old Irānian notion regarding the *Sagdīd*, as scaring away any evil influence, is quite in accordance with their conception of the *peshu-pāna* dogs. By the commandment of the *Sagdīd* and the exposition of its influence produced directly upon a dead body, the Avesta introduces, so to say, a new element in the useful characteristics of the dog's eye, viz. its magnetic power in checking the contagious impurity of a corpse. Comp. Haug and West, 'Essays,' p. 240, note 1. *Tr.*]

of the two dogs in order that they may conduct them safely to the shades:

'Those are thy watchers, O Yama, the two dogs,
The four-eyed, the path-watching, men-contemplating,
To them surrender this dead, O king,
And grant him safety and freedom from pain!'

To this is then added the wish that he may himself be spared from the dismal companions:

'The two broad-nosed, soul-robbing, brown
Messengers of Yama wander among men;
Those shall, to contemplate the sun,
Grant us once again a happy life!'[1]

In order to prove the high antiquity of this myth, I shall here only mention the guard at the gate of Hades, the hell-hound Kerberos or the dog Garm, who, according to the narrative of Edda, raises his howling at the breaking of the twilight of the gods in the depth of the Genupa Hollow[2].

If, therefore, in old Irān a dog was conducted towards the dead body, it was, originally, only intended thereby to indicate in a symbolical way, that the soul of the deceased was given over to the god of death and his followers, and was at the same time recommended to their protection. The myth itself, in conformity with the unvarying character of the Avesta religion, was forgotten in course of time, but the ceremony was firmly adhered to, and the once very ingenious custom sank into an empty unintelligible form which has survived to the present day amongst the latest adherents of the Zoroastrian doctrine[3].

It is highly characteristic, how the epithet 'four-eyed' was explained in a sober rationalistic manner. Originally, in the poetical language of the myth, the great watchful-

[1] Rig-veda X, 14, 10–12. Comp. Max Müller, 'Lectures on the Science of Language,' vol. ii, p. 435 seq.; Kaegi, *Der Rig-veda*, pp. 59–60, particularly note 337.

[2] *Völuspā*, 48.

[3] [*Vide* the translator's note a on the preceding page.]

ness of the dog was chiefly to be emphasized. Hence the precept was construed to mean that the dogs employed for the *Sagdīd* must have two black spots over their eyes that the ceremony might be efficacious[1].

After the performance of the *Sagdīd*, for which the tradition naturally gives the most detailed casuistic rules of direction, the dead body was disposed of. The disposal neither consisted in burying nor in burning, but, according to the Zoroastrian ritual, in exposing the corpse on a lonely place to be eaten by birds, dogs, and ravenous animals.

Herodotus relates that this mode of disposing of the dead was common amongst the Magi, that is, amongst the Persian priesthood. Strabo mentions it in connection with the Hyrcanians, and Cicero expressly distinguishes between the funeral customs of the Magi and those of the Persian nation[2].

Among Westerns that remarkable injunction of the Avesta regarding the treatment of the dead, which appears to us so unnatural, was also well-known. But there is no doubt that it never found acceptance throughout the whole of Irān, but was possibly confined to the North-Eastern districts and, moreover, entirely to the priesthood. The Avesta itself informs us that in *Chakhra*, that is, somewhere in the district of Meshed, the dead were burnt, and that in *Harahvati*, where people do not seem to have very strictly adhered to the Zoroastrian commandments, they were interred[3].

The exposure of the dead owed its origin, as it appears, to the natural condition of Eastern Irān. The waste lands

[1] In Vd. XIII, 9 the dog is also called *peshu-pāna* 'guarding the bridge, the passage (to the next world),' which reminds us of the *çvānau pathirakshī* in the Rig-veda; *chathur-aksha* is identical with *chathru-chashma* (Kuhn in *Haupt's Zeitschrift für deutsches Alterthum*, vol. vi, p. 125; Weber's *Indische Studien*, vol. ii, p. 296; *vide* Justi, *Hdb.* s. v.).

[2] Spiegel, *E.A.* vol. iii, pp. 703–704.

[3] Vd. I, 17 (*nasushpachya* 'the burning of the dead,') and 13 (*nasushpaya* 'the burying of the dead').

immediately adjoining its borders were themselves comparable to a gigantic grave. They to a great extent suggested the idea of conveying the dead thither and abandoning them to their fate. Besides people were also compelled to do so. when anybody—and this was certainly not rare—lost his life in longer or shorter wanderings through the sand and salt-steppes.

We must also add that, considered from a strictly logical stand-point, the burning as well as the burial of the dead contravenes the whole idea, respecting the world, of the Avesta and its followers. Through both, the impure corpse, which has fallen a prey to the demons, comes in contact with the essentially sacred and pure elements, with fire and earth. Such a pollution however was to be avoided under all circumstances.

The exposure of the dead body was certainly an old custom which, though perhaps not in general use amongst the kindred Indians, was nevertheless now and then put in practice in all urgent cases. The Atharva-veda seems to us to bear witness to this fact. It distinguishes between the *manes* of such as were buried, thrown aside, burnt or exposed. We may believe that it here enumerates the different modes of disposing of the dead, with which it was familiar and which it considered to be lawful [1].

Here everybody will naturally be reminded of the Kāfirs, a very remarkable nation inhabiting the high mountain-valleys of the Hindukush, which are difficult of access and situated on the North of Cabul. With them it is a general custom to expose the dead, without interring them, in deal chests on the summits of mountains, that is, on the most elevated points [2]. If we further consider what an im-

[1] Atharva-veda XVIII, 2, 34. The expressions are: *nikhāta*, *paropta* (from rt. *vap* + *parā*), *dagdha*, *uddhita*. Comp Zimmer, *AiL.* p. 402. We have observed that in the Avesta *uzhdāna* indeed also designated the scaffold erected for the exposure of the corpse (*Hdb.* s. v.)

[2] Masson, 'Narrative,' vol. i, p. 224: 'It is agreed that the Sīāposh place their corpses in deal boxes and, without interring them, expose them on the summits of hills.' Comp. Elphinstone, 'Kabul,' vol. ii, pp. 336–337; Spiegel, *E.A.* vol. i, p. 398.

placable hatred the Kāfirs cherish against the followers of Islam, and how they have been able to preserve their freedom and independence, especially in the exercise of their religion, in spite of all the efforts of their enemies, that remarkable custom might lead us to recognize in the Kāfirs descendants of the old Zoroastrians. It must, however, be taken into consideration here that, according to the 'Inquiries' of Trumpp, the Kāfirs speak an absolutely Indian language. At all events we shall have to wait for still fuller and surer accounts before we can form a definite opinion regarding that nation.

In the exposure of the dead, we have, therefore, to deal with a custom, which, due to local circumstances, was most probably occasionally practised before the introduction of the Zoroastrian Reform. As that custom completely corresponded to the spirit of the reform, it was accepted by its originators and laid down as a generally binding precept. But that, previous to the burning of corpses, this custom was most widely spread amongst the Indians is strikingly proved by the linguistic usage concerning it.

The place which is destined for exposure bears the name of DAKHMA. This word originally meant, as clearly appears from its derivation, nothing else than the place for burning[1].

The *dakhmas* must be erected on places situated on high, on the tops of hills or slopes. Dogs and wolves, foxes and ravenous birds can thus easily perceive the corpse there laid down and seize their prey. The so-called Towers of Silence, which serve the Parsees in Bombay as places for the disposal of their dead, crown the summit of the magnificent Malabar Hill which rises above the city. The view which they present is naturally most gloomy. A body of lazy vultures, densely crowded, guard the edge of the Tower. There they sit immovable and motionless,

[1] *Dakhma* comes from rt. *daz* = Skr. *dah* 'to burn.' [Others derive it from rt. *dak* = Skr. *damç* = Gr. δακ 'to bite.' Hence it may originally mean the place where dead bodies are consumed either by insects (in the grave), or by vultures (on the tower). *Tr.*]

save when a funeral procession approaches and the flock are filled with excitement. They fly upwards with screams, and as soon as the dead body is laid within by the bearers, they throw themselves with greedy haste upon their prey. In a few minutes the dreadful work is finished, and the birds return satiated to their place to wait for fresh food.

Originally, the *dakhmas* were certainly nothing more than natural hills or primitive elevations of sand, earth, or stones. In course of time the structure became a more elaborate one. It is a rule that the *dakhma* must be uncovered and exposed to the solar rays as well as to the rain [1].

Nor are all places suitable for the erection of *dakhmas*. Wastes and unproductive pieces of land are the most fit, for they belong already to the evil powers and are the abode of demons. But the Mazdayasna lives in a constant struggle with the desert lands themselves. Plough and hoe are the weapons with which he takes the field against them, and tries to make the land, which was before sterile, piece by piece, arable and available for 'the good creation.' Thus many *dakhmas* had to be pulled down and re-erected further off, when civilization had approached them. This explains why the closing of *dakhmas* is esteemed meritorious [2]. It is a token that another piece of land has been wrung from the evil spirits through human labour and exertion. Close to the *dakhmas* wild animals are on the watch; there dwell ghosts and demons that rejoice in death and destruction; there also, as the Irānian very well knew, are the breeding places of manifold maladies and pestilential diseases [3].

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[1] Hence the expression *hvare-daresīm · kar* 'cause that (the corpse) is looked at by the sun,' quite synonymously with 'expose the dead.'

[2] Vd. III, 9 and 13; VII, 51.

[3] Vd. VII, 58. [How Dr. Geiger could conceive this totally new aspect of the meritoriousness of pulling down the *dakhmas*, we cannot imagine. The word as it is used throughout the Avesta (Vd. III, 9, 13; V, 14, 16, 18, 51; VII, 49, 50, 51, 56, 57, 58; VIII, 2, &c.) does not mean the place for the exposure of the Irānian dead but the

The corpse, which is exposed, is laid, as it seems, on a special layer of mortar or similar material[1]. There it remains, according to the expression of the Avesta, until it is mixed with the dust, until its fatty and fleshy parts have disappeared[2]. The birds and beasts should only gnaw the flesh from the bones, the skeleton, on the contrary, remaining uninjured and complete, and for this reason the dead in the *dakhma* are weighted near the head and feet with iron chains or stones or wooden blocks. Were this not done, a wolf or a vulture could remove portions of the dead body, and with them pollute water and plants[3].

covered tomb of any person, be he Zoroastrian or non-Zoroastrian. As the Vendidad strictly orders the exposure of the dead body to the light of the sun, its consumption by vultures, and the preservation of its bones in an *astodān*, so also does it forbid closed sepulchres to the adherents of the Law, while it compels them to pull down and destroy any tomb, whereby to restore, as science has taught us but lately, the natural purity of Mother Earth, upon whom solely depends the subsistence of the animal creation. To what extent the Irānian system of exposing the dead is more beneficial to life than the practice of interment, we do not here discuss, suffice it to listen to the remarks of Prof. Monier Williams in his 'Modern India and the Indians':

'When the Secretary had finished his defence of the Towers of Silence, I could not help thinking that however much such a system may shock our European feelings and ideas, yet our own method of interment, if regarded from a Parsi point of view, may possibly be equally revolting to Parsi sensibilities.

'The exposure of the decaying body to the assaults of innumerable worms may have no terrors for us; but let it be borne in mind that neither are the Parsi survivors permitted to look at the swoop of the heaven-sent birds. Why, then, should we be surprised if they prefer the more rapid to the more lingering operation? and which of the two systems, they may reasonably ask, is more defensible on sanitary grounds?' *Vide* pp. 88–89. *Tr.*]

[1] I translate the difficult passage, Vd. VIII, 10, thus: 'Then shall two men, as strong and skilful as possible, bring it (the corpse) near naked and unclad, and shall lay it down upon a pile of clay or stone or upon a wooden scaffold [rather cement] (by which the *dakhma* is naturally meant) in mortar upon the earth.'

[2] Vd. VII, 49.

[3] Vd. VI, 46. The passage Vd. V, 3–4, only apparently militates

The skeleton requires peculiar treatment. After a certain time it is removed from the *dakhma* and brought to a place where beasts cannot enter, and where it is no longer exposed to the rain[1]. A detailed description of the charnel-house is wanting in the Avesta. The modern Parsees cause the *dakhma* to be cleaned twice every year, on which occasion the bones are thrown through a large opening in the middle of its surface, into the interior of the tower[2]. It is possible that in ancient times also an excavation was left open in the *dakhma* as a receptacle for bones. It may however be also assumed that originally the ossuary was altogether separate from the place of exposure. The skeleton also was deposited on a base of stone or mortar or on carpets. In case that could not be done, common coverings or mats, such as those which were then used for sitting and resting upon, would suffice.

The diverse mode of treatment of the whole body and of the bones remaining is grounded probably on the notion that the impurity of the corpse attaches itself above all to its perishable parts, and that, therefore, the latter must be subjected to an annihilation as speedy as possible, while the bones meet with a worthier treatment. This custom corresponds in a striking way with a statement of Justin respecting the Parthians, that they abandoned their dead to the birds and dogs, but interred the bones when stripped of the flesh[3].

It was ordered in the Avesta to convey the dead only in fine and clear weather to the *dakhma*. The sun should

against such an idea, for it only brings out prominently that the *man* does not become polluted by the carcass having been dragged away by dogs, wolves, birds, winds, or flies; here, on the contrary, the question is one respecting the contamination of water and plants.

[1] With the whole section compare the beginning of Vd. VIII, as well as Vd. VI, 44–46, 49–50. The twofold treatment of the whole corpse and of the skeleton in particular, according to my comprehension of the last passage, is illustrated in my *Handbuch* at the foot of page 99.

[2] Spiegel, *Av. üb.* vol. ii, p. lvi.

[3] Justin, 41, 3, in Spiegel, *E.A.* vol. iii, p. 704

shine over them in their last journey, perhaps in accordance with the old popular idea, which compares the dying of the man with the setting of the sun in the West. In case dark and inclement weather prevailed, the exposure had to be postponed. In connection with this the Avesta expresses itself as follows:

> 'If in the house of a Mazdayasna a man or a dog die, and if it rain, or snow, or storm, or if it be dark or if it be a day, when men and animals are prevented from going out, what shall the Mazdayasna do?'

It is then prescribed, that for such cases there shall be in each village and on each farm three *katas*, 'pits or cavities.' They must be situated in a place cleared of all plants and entirely dry, where neither men nor animals pass, and which is a few steps distant from fire and water, from sacred chattels, and from the dwellings of pious men. Such a *kata* serves as a principal receptacle for the dead. It must be of a certain size, so that the corpse may not strike against the sides either above or below. Besides, the bottom must be strewed with sand or brick-dust, probably in order to prevent the corpse from touching the earth, and to keep away all moisture:

> 'Here they shall deposit the lifeless body for two or three nights long, or for a month, until the birds fly again and the plants germinate, until the waters run again towards the valley and the wind dries the earth. And afterwards, when the birds fly again and the plants grow, when the waters flow again towards the valley and the wind dries the earth: then the Mazdayasna shall (bring the dead body to the *dakhma* and) expose it to the sun[1].'

[1] Vd. VIII, 4–10; V, 10–13. Both of the passages treat evidently of the same subject, as it occurs frequently in the Vendidād, though in somewhat different ways. Instead of the detailed description of the weather, which is found in Vd. VIII, we have in Vd. V. only 'but when the summer has passed and the winter sets in;' the sense of course is quite the same. In Vd. VIII. the provisional pit is called *kata*, in Vd. V. *avakana*; there the *dakhma* is called *shemba* 'scaffold.' Comp. also my *Hdb.* p. 81, note 2.

If any contact whatever with a corpse caused pollution, such pollution must have fallen to a great degree upon the people who carried the dead to the *dakhma*. Hence this work was in ancient as well as in modern times performed, not by the survivors, but by corpse-bearers, specially appointed for that purpose[1], whose profession was generally held in abhorrence, its representatives being excluded from human society. . . . . .

Never can one man alone bear a corpse. as such an action would render him polluted for ever, even in the next world. There must always be two, who, after having finished their business, must undergo a special purification. This consists in the washing of the head and of the body with the urine of cows (and water). . . . . .

The dwelling of the corpse-bearer lies apart from the houses of other men, and nobody holds any intercourse or communion with him. In a barren, waste region does he live, evidently in a kind of a cavern. He is only scantily furnished with food and clothing; a poor and miserable life shall he lead until his old age. . . . . .

As soon as the corpse was laid in the *dakhma* and abandoned to wild animals, there was yet a long period of mourning for the survivors. The commandments, originating in a later period concerning the ceremonies which were performed in the name of the dead to honour his memory, I may here conveniently pass over, as they have been collected and treated of before[2]. According to the Avesta, the relatives of the deceased had to refrain for a time from all intercourse with men[3]. During that time they devoted themselves exclusively to the remembrance of their beloved

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[1] This statement is based on Vd. III, 14–21 (besides Vd. VIII, 10), with which we should compare *ZddmG.* vol. xxxiv, pp. 419, 420. The corpse-bearer is called *nasukasha* or *iristō-kasha*, by the modern Parsees *nasāsālār*. *Vide* Spiegel, *Av. üb.* vol. ii, p. xxxiv; Dossabhoy Framjee, 'The Parsees,' p. 92.

[2] Spiegel, *Av. üb.* vol. ii, p. xxxviii. seq.

[3] Vd. XII. Comp. above all Darmesteter's Vendidād, introduction to that chapter.

dead, and sent up their prayers to Ahura Mazda for him and for his eternal salvation.

The soul, however, delivered from the shackles of the body and freed from the clay of this earthly life, was borne up into higher worlds.

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## 11. *Immortality*[1] *and Eschatology.*

THE belief in the continuation of existence after death, in a future world into which enter souls leaving their mortal

[1] ['Next to the being of a God, the doctrine of the Immortality of Man lies at the foundation of all religion, and of all the animating prospects which can cheer us in the land of our pilgrimage. Remove from the mind the belief of a future existence and the hope of immortality, and religion becomes a shadow, life a dream, and the approach of death a scene of darkness and despair. Upon this short question, "*Is man immortal, or is he not?*" depends all that is valuable in science, in morals, and in theology, and all that is most interesting to man as a social being, and as a rational and accountable intelligence. If he is destined to an eternal existence, an immense importance must attach to all his present affections, actions, and pursuits; and it must be a matter of infinite moment, that they be directed in such a channel as will tend to carry him forward in safety to the felicities of a future world. But if his whole existence be circumscribed within the circle of a few fleeting years, man appears an enigma, an inexplicable phenomenon in the universe, human life a mystery, the world a scene of confusion, virtue a mere phantom, the Creator a capricious Being, and his plans and arrangements an inextricable maze.

'Since it appears that the desire of immortality is common to mankind, that the soul is incessantly looking forward to the enjoyment of some future good, and that this desire has been the spring of actions the most beneficent and heroic, on what principle is it to be accounted for?

'Whence springs this pleasing hope, this fond desire,
This longing after immortality?
Or, whence this secret dread, and inward horror,
Of falling into nought? Why shrinks the soul
Back on herself, and startles at destruction?'—*Addison.*]

frame, in a judgment and recompense in that world, is found amongst the most diverse nations on our globe, in a form sometimes more and sometimes less distinct and definite

Among the Indo-Germanic races this belief was evidently deep-rooted, and formed an essential portion of their doctrine.

According to the Rig-veda, the spirits of the dying follow *Father Yama* the primeval sun-god, into his distant realm, on the path which he has trodden before them. There the '*Fathers*' assemble round him, in order to enjoy convivial feasting in the middle of heaven under the dense foliage of trees:

'Where light is, which never becomes extinct,
And where the heavenly radiance glitters,
There, into the immortality,
The eternal, carry me, Soma!

'Where king is Vaivasvata
And where the innermost region of heaven is,
Where those eternal waters are—
O Soma, make me immortal!

'Where one, according to wish, stirs or moves,
In the third stage of the kingdom of heaven,
Where all the rooms are resplendent—
O Soma, make me immortal!

'Where wish and aspiration are gratified,
At the highest point in the sun's rotation,
Where desire and gratification exist together,
O Soma, make me immortal!

'Where pleasure and mirth and gaiety
And delight reside, where the will
Of the willing is attained—
O Soma, make me immortal!'[1]

In the Homeric poems a two-fold conception prevails regarding the next world, which is looked for at the confines of the world, in the remote part of the West, or in the

[1] Rig-veda, IX, 113, 7 seq.; Geldner and Kaegi, *Siebenzig Lieder des Rig-veda*, p. 111; Zimmer, *AiL.* p. 408 seq.

depths of the earth. It is a dismal and foggy land, hateful alike to men and gods, in which the souls of the departed lead a visionary and fantastic life. Besides this there is also found the milder and more agreeable picture of the Elysian fields, where the fair Rhadamanthus reigns, and where there is neither snow, nor storms, nor even showers of rain, but where a cool west wind blowing from the ocean refreshes men. Indeed these blessed fields are at first only the paradise of specially favoured men, who, without undergoing death, are carried thither by the gods[1]. I believe, however, that these descriptions have their foundation in old legends of a more beautiful and better future world. In fact in a later period only *one* Hades is mentioned, in which the good and the bad both find a place, the former in the fields of the blessed, the latter in the space set apart for the damned.

A very striking analogy to the views of the Greeks is presented by those of the old Germans. Those men who perish fighting and remain on the field in the heat of battle are conveyed into the illuminated hall of the *Walhalla*, where they, together with Odin, the war-father, enjoy merry war-games and jovial feasting. However all other men. good and evil, wander into *Hel*, which is represented as a dismal, misty region like the Hades in Homer[2].

But nowhere, I think, does the belief in the future life after death stand out more prominently, nowhere are the ideas respecting it expressed more decidedly and carried out in all their details more fully, than among the Avesta people.

Here the doctrine of immortality and of compensating justice in the next world forms a fundamental dogma of the whole system. Without it the Zoroastrian religion is in fact unintelligible. If all the powers which contend upon

[1] Odyssey, bk. XI, l. 15 seq., l. 155 seq., ll. 474–476, ll. 489–491; Iliad, bk. XXII, l. 482; bk. XX, l. 61 seq.; Od. bk. IV, l. 561 seq.

[2] Hence the names *Niflheimr* 'land of mists' and *Niflhel* 'misty hollow.' Comp. Gylfaginning, p. 49 (Simrock, *Edda übersetzt*, p. 319); on Walhalla comp. Grimnismal, 8, 23; Gylf. 38–41 (idem 15, 303–305).

earth for the kingdom of light were lost, the conviction of divine justice would have to be abandoned.

So far as we are able to follow up the Mazda doctrine, we find that, even in the first period of its foundation, the belief in immortality is strong and active. For who in that age would have fixed his choice upon a new religion, if the hope of a better life after death had not been held out to him as the reward of all the troubles and hardships to be endured for its sake?

Accordingly, the first proclaimers of the Mazda religion in their teaching and preaching speak directly of the next world as being the greatest of all possessions, of the eternal beatitude of the pious, and of the eternal damnation of the impious. The believer belongs to the spiritual world, he shall enter into it; the corporeal world is only the transitory scene of his activity, his battles, and his trials.

'Whosoever in righteousness shows to me
The genuine good actions, to me, who am Zarathushtra:
Him may they (the divine beings) grant, as a reward, the next world,
Which is more desirable than all others[1].'

'That man may attain the best of all good,
Who exhibits to us the direct path of bliss
In this corporeal world, and in that of the spirit,
Towards the pious people with whom Ahura dwells
It is he, the Singer, who surrenders himself to Thee,
O Mazda! Who art wise and blissful[2]!'

According to the Hellenic belief, the souls wandering in

[1] Ys. XLVI, 19. *Vasnā frashotemem* at the end of the second verse literally means 'standing in the uppermost place with a wish (a desirableness),' and refers, I believe, to *parāhum* (*vide* Haug, *Gāthās*, vol. ii, p. 154; Spiegel and C. de Harlez differ). This expression is the same as the otherwise written *parō-asna · aghu. Hanenti* may be translated 'they may grant.'

[2] Ys. XLIII, 3. *Vaghēush · vahyō* is literally 'what is better than the good.' The *hvō · nā* in the beginning is to be taken with *aredrō* of the last verse (*vide* Haug, *Gāthās*, vol. ii, pp. 65–66).

the next world must either pass over the ocean or be allowed to cross over the rivers of the nether regions in the boat of Charon. The northern legends of the Edda make mention of a bridge, the Gioell Bridge, by which the dead enter *Hel.* The people on the western coast of Gaul believed that their dead were carried by mariners over the sea to the foggy and gloomy Britannia [1].

According to the Rig-veda also the departing soul has to pass immense oceans before it reaches the next world. At one time it is a boat, at other times a bridge, 'the Bridge of Happiness,' by means of which it crosses [2].

On such ideal conceptions also rests the doctrine of the Avesta regarding the *Chinvat Bridge*, more probably 'the Bridge of Retribution,' upon which justice is administered to the departing souls [3]. The bridge was believed, I think, to have been built over a wide expanse of water, which separates Paradise from this world. Only he who is found pious and good before the holy tribunal is entitled to cross this bridge, but the wicked one is thrown into outer darkness and hell.

Thus it is said in the Gāthās:

'What man or what woman, O Ahura Mazda!
Achieves for me in this life the best actions that Thou knowest,
(That bring) blessing for the pious, and power by means of the Good Sense,
And those, whom I call to follow me in your praise:
With all these will I cross over the Chinvat Bridge!'

'But with the princes the idol-worshippers and the false priests unite themselves,

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[1] Procopius, *De bello Gothico*, 4, 20; *vide* Grimm, *Deutsche Mythologie*, 2⁴, 694–695.

[2] Rv. IX, 41. 2, *suvitasya manāmahē 'ti setum.* Comp. Zimmer, *AiL.* p. 409.

[3] *Chinvatō · peretu* is probably not the 'Bridge of the Assembler,' as I have previously rendered it, but the word *Chinvat* should be derived from the root *chi* 'to suffer, to punish.' Cf. *chitha.* In Vend. XIX, 30, the bridge *Chinvat* is explained by *haetu · mainyavanãm · vazatanãm.*

To destroy human life by means of evil deeds.
The former will greatly distress their own souls and their own conscience,
When they arrive there where the Bridge of Retribution is,
For all eternity do their bodies belong to the habitation of the devils!'[1]

The region into which the pious departed enter is the *Garō nmāna*, 'the abode of hymns,' as the name may be well translated. Here all is light, splendour, and glory, here reigns Ahura Mazda with all the angels, praised by the anthems of the blessed.

Opposite to Paradise lies the abode of the condemned, Hell or 'the dwelling of the demons[2].' Here eternal night and darkness reign, and the scorn of the demons further enhances the pains and torments, which the fallen soul, doomed to eternal damnation, has to endure.

To the pious the Bard says:

'Whatsoever reward Zarathushtra before conferred upon the truly faithful,
(Saying), "In the *Garō nmāna* Ahura Mazda is first of all perceived,"—
Would be conferred upon you, together with happiness, on account of your good mind and piety[3].'

On the contrary the following threat is pronounced against the impious, who oppose the new doctrine:

'Whoso brings about that the pious man is defrauded, his dwelling is finally
For a long time in darkness, and vile food and irony (shall fall to his lot).
Towards this region, O ye vicious! your souls will conduct you on account of your actions[4].'

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[1] Ys. XLVI, 10–11. I take *astayō* in 11 as nom. plur. of *asti* '*corpus*, body;' comp. Ys. XLIX, 11, Spiegel, *Comm.* vol. ii, p. 375.

[2] For another use of this expression, *vide* Yt. X, 86, *supra*, p. 30.

[3] Ys. LI, 15. I believe the meaning to be as follows: Ahura Mazda has first entered into Paradise; thither the pious and the faithful will follow Him according to the promise of Zarathushtra.

[4] Ys. XXXI, 20. *Dāyat* is to be read in the first line (Bartholo-

'The wicked rulers, offenders and liars,
The unbelieving, who are of evil mind and wicked,
Do the souls come to meet with vile food (in Hell).
In truth their bodies will remain in the dwelling of the demons (*Drujas*)!'[1]

The ideas of the later Avesta harmonize entirely with those of the Gāthās. Thus the doctrine of immortality and of eternal judgment was firmly established in the earliest period of the Mazda religion as an essential dogma, and naturally remained so throughout the whole period.

Mention is very often made of the two worlds, the present and the future, the earthly and the heavenly[2]. The idea which was in the oldest ages only incipient, existing as it were only in embryo, became more and more perfect with the development of this religion, and was more and more worked out in all its details.

An exact description of the fate of the soul after death is found in Yasht XXII. Unfortunately it is incomplete. But as the Minokhired treats of the same subject, and agrees entirely with the Avesta text, so far as that text is preserved, we may be allowed to utilize it to supply the deficiency[3].

The soul of the pious man, as I have already remarked, remains near the head of the corpse, for three days and three nights, after death has taken place. During this time the soul experiences, as a foretaste of the joys of Paradise, greater delight and happiness than it ever enjoyed during its entire life upon earth.

On the beginning of the fourth day, with the appearance of Aurora, when the gates of the heavens are opened, the soul passes over the Chinvat Bridge. Here justice is

mae, *Gāthās*, XXXI); I would insert *chā* after *avaetās* in the second line.

[1] Ys XLIX, 11.

[2] *Ubōibyā · ahubyā*, Ys. XXXV, 3; *uvaēibya · ahubya*, Ys. LVII, 25; *ahmāichā ahuyē · manahyāichā*, Ys. XL, 2; *parō-asnāi · aṅuhē*, Ys. LV, 2. Haug and West, 'Essays,' p. 310 seq.

[3] Yt. XXII; *Minokhired*, 2, p. 114 seq. (West, *Mkh.* 9, 69, 133); comp. Vd. XIX, 27–32. Haug and West, 'Essays,' p. 219 seq., 254–255; Spiegel, *E.A.* vol. ii, pp. 149–151.

administered to it[1]. Angels like Srausha, Verthraghna, and the Good Vayu, stand by and support it. Demons, especially the death-bringing Astōvidhōtu and the Wicked Vayu, bearing ill-will towards it, endeavour to secure it for themselves.

Rashnu the Just holds in his hands the scales in which good and evil deeds are weighed against each other—he, who does not yield even a hair's breadth, before whom kings and princes prevail no more than the most indigent and base among men.

Mithra and Srausha intercede on behalf of the soul, evil spirits raise accusations against it. If its pious deeds outweigh the evil ones, it is allowed to pass over the bridge into Paradise.

Under certain conditions it also appears to have been permitted to a particularly pious soul with a surplus of good deeds to render assistance to another that was deficient therein—which would at all events be remarkably analogous to the Catholic belief in saints in many countries. The surplus good works were preserved in a proper region, the *Misvāna*[2].

The Chinvat Bridge appears to the pious soul 'a *farsang* in breadth.' The soul on passing over it meets a most fragrant wind blowing from the southern regions of heaven. It is the breeze wafted from Paradise. And in this wind there appears to the Soul 'its own conscience' in the shape of a charming maiden[3]—a pretty symbolical impersonation of the inner peace and quietness of soul, which the righteous man enjoys.

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[1] *Chinvat-perethum · Mazdadhātãm · baodhascha · urvānemcha · yātem · gaethanãm · paiti-jaidhyeiñti · dātem · astvaiti · aghvō*, 'the bridge *Chinvat*, created by Mazda, where they question the spirit and the soul regarding their behaviour on earth, which they practised during their existence in the body,' Vd. XIX, 29.

[2] *Vide* Justi, *Hdb.* sub voce *miçvāna*. The Misvāna cannot be compared with the *hamēstagãn* of the later Pārsi books (*vide* West, *Mkh. Glossary* s.v.).

[3] *Hava · daeṇa* Yt. XXII, 9. The *Minokhired* has a more indefinite expression, *ã i hvēsh kuneshn nīk.*

With astonishment does the soul ask. 'Who art thou, O Maiden, that seemest to me more beautiful and fair than ever a maiden of earth?' Its conscience replies:— I am thy own doing and acting, I am the embodiment of thy good thoughts, words and works, and of thy pious faith,' and then it recounts all the good works which the soul accomplished during its earthly career.

Now the soul enters, at the first step, into Paradise, *Humata*, the place of good thoughts, at the second into that of good words, *Hūkhta*; and at the third into that of good works, *Huvarshta*. Just as all righteousness on earth is divided into the three heads of thought, word, and deed, so also is Paradise, the reward of piety, divided into three regions.

At the fourth step the soul finally attains the region of imperishable splendour, that delightful Paradise, where Ahura Mazda dwells together with angels and the blessed spirits of the earlier pious dead [1].

Vohu Manō, the greatest of the Amesha Spentas after Ahura Mazda, and all the Yazatas rise from their golden seats and question it: 'How comest thou here from the world of mortality and misery to this world of eternity and enjoyment?' But Ahura Mazda says; 'Question it not; it cometh on the awful path of separation of the body and the soul.' Therewith the soul is received into the number of inmates of Paradise; it is conducted to the gold-adorned throne destined for it, and entertained with the most costly of viands.

The fate of the souls of the impious is in all respects the opposite to that of the souls of the pious.

In helpless and despairing anguish the wicked soul wanders about near the corpse for three days and three

[1] The names of the particular regions of Paradise, viz. *Humata*, *Hūkhta*, *Huvarshta*, and *Anaghra-raochāo* are contained in Yt. XXII, 15. Other designations are *tem · ahūm · yim · ashaonãm* 'the world of the pious,' Vd. XVIII, 76; *vahishtem · ahūm · ashaonãm · vīspōqāthrem*, *maethanem · Ahurahē · Mazdāo*, *maethanem · Ameshanãm Speñtanãm*, *maethanem · anyaēshãm · ashaonãm*, Vd. XIX, 36. From Av. *vahishta* is derived the N.P. *bihisht* 'Paradise.' On *Garonmāna*, *vide* Yt. X, 123; III, 4.

nights. Even now it feels the weight of all the torments and horrors which await it in Hell The demon of Death drags it forth in fetters, and when near the Chinvat Bridge the formidable sentence has been pronounced over it,—'Thou art weighed and found wanting,'—it passes towards the region of the condemned.

A foul wind coming from the North meets it, and in that wind it perceives its own conscience in the shape of an ugly hag—the embodiment of all the torments of soul which it feels. Shuddering the Soul asks: 'What art thou, O maiden, that appearest to me more ugly than ever an earthly maiden?' And it receives its reply as follows: 'I am thy own doing and acting, the embodiment of thy evil thoughts, words and works, and of thy false belief!'

As the soul of the pious enters Paradise, the soul of the damned now enters into Hell; first into the place of evil thoughts, next into that of evil words, thence into that of evil works, and lastly into the region of eternal darkness, into the terrible dismal hell full of suffering[1], which is the abode of Angro Manyu and his followers. Here it is received by the demons with scorn and mockery, and the prince of hell causes it to be furnished with the most foul and nauseous of eatables, loathsome to the taste of men[2].

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The doctrine of the Avesta regarding the fate of the soul after its departure from this world is directly followed by Eschatology, the doctrine of the last things and of the end of the world.

The visible world is the scene of contest between Ahura Mazda and Angro Manyu, between the good genii and the demons, between the pious and the impious. But this conflict is not an everlasting one, it will end in the complete triumph of the good cause. As, moreover,

[1] Hell is called *duzhagh* or *daozhagha*, Yt. XIX, 44, Vd. XIX, 47; comp. the epithets *ereghat, temagha, temaschithra*, Vd. III, 35, V, 62.

[2] 'Mockery and foul eatables' are even mentioned in the Gāthās as punishments of Hell. *Vide supra* p. 101.

the earth, by the invasion of the evil spirits, is much disturbed and deformed, its transformation and renovation goes hand in hand with this triumph.

Already in the old hymns the 'dissolution of the world' is spoken of, when the wicked will receive their punishment, and the good their reward:

'I thought of Thee as the blissful, O Mazda Ahura,
Because I saw Thee as the first one in the beginning of the world,
Because Thou didst first commence the work (of sacrifice) and the speech, promising reward;
Namely, evil for the bad, but good blessing for the pious,
By means of Thy Glory at the final dissolution of creation [1].'

If by this a complete annihilation of the world be indicated, the passage seems entirely isolated. However it probably refers, in accordance with the general doctrine of the Avesta, only to a regeneration and renovation of the world, which is of course preceded by manifold conflicts, and especially by the extirpation of all evil.

At all events it is important to note that the everlasting destiny of the good and the wicked is, according to that passage, sealed by the end of the world.

A final judgment also is coupled with the end of this world.

This idea stands only in apparent contradiction to what is said above, when, consistently with the notion of the Avesta, judgment is pronounced upon the soul immediately after its departure from this world, and the soul in accordance with that decree finds admission either into Paradise or into Hell. Here the soul alone is concerned. But at the end of the world the bodies of the dead will also rise and will share thenceforward the fate of the soul for all eternity.

In the Christian doctrine, which in its very eschatology

[1] Ys. XLIII, 5: *dāmōish · urvaęsē · apēmē*, which is apparently contrasted with *aghēush · zāthōi* in verse 2.

shows the most curious analogy to that of the Parsees, we meet with the same seeming dilemma. On the one hand, it is indeed believed that the spirit of the dead goes forthwith towards God, or towards the place where it suffers the torments of those separated from Him. On the other hand, the Christian Church teaches that the solemn judgment of the world will only take place on the last day and at the return of Christ.

The dogma of the resurrection of the body belongs, according to my view, already to the Gāthā period, thus to the oldest period of the Zoroastrian religion[1]. The

[1] [Dr. Ferdinand Justi in his discourse upon Dr. Geiger's *Ostiranische Kultur* (*vide Deutsche Litteraturzeitung*, 1883) seems to view the matter thus —The belief in the Immortality of the Soul is in the Zoroastrian doctrine original, but the faith in the Resurrection of the Body could not have originated with the Zoroastrians since they immediately consign the body to destruction. It must have originated from a country where people indicated their belief in a future existence of the body also externally (i e. by interment in sepulchres or by embalmment of the corpse). Thus it was introduced from Anterior Asia into the land of the Avesta people.—In the first place, it should be observed that from the Avesta precept that the dead body shall be consumed by carcass-eating birds, we must not infer that the Zoroastrian religion does not at all inculcate its preservation. Along with the precept regarding the immediate consumption of the corpse, there is also a strict commandment for erecting an *astōdān* (charnel-hollow) for the preservation of its bones (*vide* Fargard VI, at the end). It is only for the fleshy and fluid portions of the human body, which, after death has taken place, are subject to putrefaction and consequently exercise a destructive influence on the living, that the Vendidād explicitly orders its annihilation, while at the same time it commands the proper preservation of the bones. Moreover, the violation of this command is liable to heavy penalties set down in the law In the second place, the passages referring to the *Frashōkereti* 'the advancement or new formation' in the Gāthās, as well as the description of the Resurrection given in the *Jamyād Yasht*, as interpreted by the author in the text, clearly prove that the resurrection-theory was established in Eastern Irān long before it was propounded by any other monotheistic religion of the civilized world. That Spitama Zarathushtra was the first known prophet by whom this doctrine was revealed to

*bodies* of the wicked, as it is said in the Avesta, pass into Hell; where they are condemned to corporeal punish-

man is confirmed by several Christian writers, amongst whom I would here quote the view of an American author upon this question (*vide* 'History of the Doctrine of Future Life,' by W. R. Alger, Boston, 1880, pp. 140–141):—

'The doctrine of a general resurrection is literally stated in the Vendidād, and in many other places in the Avesta, where it has not yet been shown to be an interpolation, but only supposed so by very questionable constructive inferences. The consent of intrinsic adjustment and of historical evidence, therefore, lead to the conclusion that this was an old Zoroastrian dogma In disproof of this conclusion we believe there is no direct positive evidence whatever, and no inferential argument cogent enough to produce conviction.

'There are sufficient reasons for the belief that the doctrine of a resurrection was quite early adopted from the Persians by the Jews, not borrowed at a much later time from the Jews by the Parsees. The conception Ahriman, the evil serpent bearing death (*Die Schlange Angramainyus der voll Tod ist*), is interwrought from the first throughout the Zoroastrian scheme. In the Hebrew records, on the contrary, such an idea appears but incidentally, briefly, rarely and only in the later books. The account of the introduction of sin and death by the serpent in the garden of Eden dates from a time subsequent to the commencement of the Captivity. Von Bohlen, in his Introduction to the Book of Genesis, says the narrative was drawn from the Zend-Avesta. Rosenmuller, in his commentary on the passage, says the narrator had in view the Zoroastrian notions of the serpent Ahriman and his deeds. Dr. Martin Haug—an acute and learned writer, whose opinion is entitled to great weight, as he is the freshest scholar acquainted with this whole field in the light of all that others have done—thinks it certain that Zoroaster lived in a remote antiquity from fifteen hundred to two thousand years before Christ. He says that Judaism after the exile—and, through Judaism, Christianity afterwards—received an important influence from Zoroastrianism, an influence which, in regard to the doctrine of angels, Satan, and the resurrection of the dead, cannot be mistaken. The Hebrew theology had no demonology, no Satan, until after the residence at Babylon. This is admitted. Well, is not the resurrection a pendant to the doctrine of Satan? Without the idea of a Satan, there would be no idea of a retributive banishment of souls into hell, and of course no occasion for a vindicative restoration of them thence to a former or a superior state.

ment[1]. In the later Avesta this dogma is fully expressed in clear words and the resurrection is brought into connection withthe regeneration of this world[2].

The Bundehesh contains a distinct chapter on the end of things. It cannot be my task here to repeat its contents[3]. I will rather enter into those points of Parsee eschatology which are found already in the Avesta, and I will also refer as much as possible to the age and primitive form of these different dogmas.

The end of the world consisted in a regeneration of creation. This is evident from the expression by which that event is constantly referred to in the Avesta[4] This expression, moreover, is even used in the more ancient Gāthās, where the poet desires for himself and his friends that they may be included among those who will help to renovate the world[5].

As is well known, the idea of the return of Christ, and the hope in the same, were especially lively among the primitive Christians. As it appears, the end of the world was also believed, in the very first period of the Zoroastrian community, to be closely impending Or can this doctrine, which later on appears in the Parsee writings, have been in force at that time, according to which a small number of

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'In view of the whole case as it stands, until further researches either strengthen it or put a different aspect upon it, we feel forced to think that *the doctrine of a general resurrection was a component element in the ancient Avestan religion*' *Tr. note*]

[1] Ys. XLVI, 11; *vide supra*, pp. 100–102.

[2] Yt. XIX, 11 and 89: *yat · irista · paiti · usehishtā*. Comp. also Vd. XVIII, 51 . . .

[3] *Bundehesh*, chap. 30. West, 'Pahlavi Texts,' part 1, p. 120 seq. Comp. on the whole Hübschmann, '*Die parsische Lehre von Jenseits und jüngsten Gericht* in the *Jahrbücher für prot. Theol.* 1879, pp. 203–245; Windischmann, *Z. St.* p. 231 seq., Spiegel, *E. A.* vol. ii, p. 158 seq.

[4] *Frashō-kereti* 'the advancement, extension and new formation.' Verbal form *frashem · kar*.

[5] *Atchā tōi vaęm hyāmā, yōi īm frashēm kerenaon ahūm*, Ys. XXX, 9

chosen pious men are to be preserved in order to help the 'Saviour' in the renovation of the world? But in whatever manner we may understand it, so much is certain, that at least the fundamental features of the Parsee eschatology reach back to the earliest period of the existence of their community, and belong to the oldest and most original doctrines of their system.

If we enter into details, we are really obliged to adduce our quotations from the more modern Avesta for the sake of proof. But still we cannot hence infer in any way that the dogmas contained therein were foreign to the Gāthā period.

The day of doom is preceded by the appearance of three great prophets. Every one of these appears after the expiration of a certain period, every one is regarded as a supernaturally-begotten son of Zarathusthra . . . .

The three prophets are called *Ukhshyat-erta* 'growing piety,' *Ukhshyat-nema* 'growing prayer,' and finally *Astvat-erta* 'embodied piety[1].' The last one is plainly the 'Saviour,' the Redeemer of the world, whom the faithful people expect and long for[2]. His mother is *Erdhat-fedhri*. She bears also the name *Vispa-tarvi* 'the all-conquering,' since he who will be born of her will overcome all torments which originate from men or demons[3].

It is also said, that the *Astvat-erta* shall come from

[1] Yt. XIII, 128. The meaning of the name is explained by Hübschmann, *ZddmG*. vol. xxxv, p. 180.

[2] Yt. XIII, 129: 'Who will be the victorious saviour with the name of *Astvat-erta* "embodied piety." He is called the saviour, because he will be the safety of the whole world; he is called embodied piety, since he, as a corporeal being of flesh and blood, (*astvão hã ushtanavão*), is opposed to the annihilation of corporeal existence.' —*Saoshyãs*, plural *saoshyañtō* from root *su* 'to help, to rescue,' serves as a designation for a saviour or prophet. Even in the Gāthās *saoshkyañtō* or *saoshyañtō* occurs frequently (the singular form also once); however, I doubt whether it has even here the dogmatical import of the later Avesta. It appears to me better to designate thereby chiefly the teachers and preachers of the Mazdayasnān Community.

[3] Yt. XIII, 139; cf. Yt. XIX, 92; *Vīspa-taurvayāo puthrō*.

the lake *Kansu* far distant in (?) the East[1], the original fountain and abode of light It is his task to carry out the renovation of the world. He makes the living immortal, the dead he awakens from their sleep. Age, death, and decay he brings to an end. Eternal life, eternal happiness, and the fulfilment of all desires he bestows upon the pious[2].

But as, according to the German mythology, in the 'twilight of gods' the new earth emerges out of the turmoil of the world's conflagration and of the general battle of gods and giants, so also, according to the ideas of the Zoroastrians, a mighty combat precedes the end of the world.

The demons and their adherents[3] rise once more with all their might to annihilate the *Astvat-erta* and his companions, who are helping him in the execution of his great work. The last decisive battle takes place between the powers of light and those of darkness. Every genius finds his special opponent among the demons. *Vohu Manō*, the spirit of the Good Mind, fights against *Akem Manō*, the spirit of the Bad Mind; *Haurvatāt* and *Amertāt* against Hunger and Thirst; the genius of Truth against the genius of Falsehood; and, finally, *Ahura Mazda* himself against *Angra Manyu*, the Prince of Hell.

But *Astvat-erta*, with the help of the good genii, emerges victorious. The demons are vanquished, evil itself is extirpated. And since all evil originates from the demons, a state of undisturbed bliss is now established, in which the spirits of the pious, no longer injured and attacked by any hostile power, live together with Ahura Mazda and the other genii.

[1] Vd. XIX, 5; Yt. XIX, 92. [2] Yt. XIX, 11–12, and 89 seq.
[3] According to Yt. XIX, at the end.

## § 12. *The Cult of the Manes.*

WITH the belief in the immortality of the soul the veneration of departed spirits is naturally connected.

Delivered from the care and misery of this world, the soul has departed to the next. There it now dwells, where also the Deity dwells—in a better and more beautiful land. Manifestly it cannot have lost in strength and faculties, but it can only have gained. People, therefore, began to ascribe to it qualities which otherwise plainly describe the divine nature.

If the soul still really exists, there is no cogent ground for considering all intercourse with it as suspended. Pious remembrance, besides, yearns to maintain that communication, and clings to the hope that the body alone may fall a prey to death, but that the soul, invisibly yet perceptibly, may hover over those that remain behind.

It has been known of many a man that anxiety on account of a wife, a child, or a relation, has rendered death so painful to him, that in his last moments he feared for his hereafter and the welfare of those belonging to him. Should all this solicitude and love terminate with his death? Should the soul now suddenly forget all those for whom it has restlessly worked and provided during its life-time? That would be inconceivable, if the spirits of the dead were regarded as higher, more perfect, and more mighty beings than the souls of the living.

So, next to love and reverence for them, personal interest made it desirable to be in communication with departed souls. In them were to be found affectionate advocates near God. In direct proximity to the Deity there were beings with whom men had once been linked by ties of blood, and in whom they could also presuppose a special sympathy for their own good-fortune and welfare, a particular understanding of their special wishes and needs.

From the wish to the belief, however, is only a step.

The Avesta people speak of the *manes* of the dead as the *Fravashis* Taken strictly, we must understand by the Fravashi, that divine part in men which, existing from eternity to eternity, unites itself only for a limited time with the body. Consequently there are Fravashis of such as are dead, of such as are at this time living, and of such as are yet unborn[1]. As regards the veneration of the *manes*, naturally those of the first class only are meant.

The worship of the *manes* was a family rite among all Indo-Germanic races. Every one cherished most the memory of those who had when living been nearest and dearest to him. From such could also be expected the readiest help and support in all need and danger. Furthermore, the closer the ties of blood and relationship were considered to be, and the greater the consciousness which men felt, as belonging to this or that family, this or that clan, the more would that family rite develop and command respect.

I have already alluded several times to the fact that the family pride of the Eastern Irānian people was extremely vigorous. In consequence of this also does the religious veneration of the *manes* play a very important part in their system.

The nation[2] is based upon the family, which developes itself into the clan, the clan growing into the tribe. There were also Fravashis of the family, of the clan, of the tribe, of the country[3], spirits of the deceased relations of the family, and spirits of the members of the clan, tribe, or country. They had all more or less claim to honourable commemoration, and in a certain measure to a special worship. But in preference to all others, offerings were

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[1] *Mat vīspābyō ashaonibyō fravashibyō, yāo irīrithushãm ashaonãm, yāoscha jvañtãm ashaonãm, yāoscha narãm azātanãm* (*frasho-charethrãm saoshyantãm*), Yt. XXVI, 6. The last words are used as an epithet of a *diaskeust*, who in this passage would recognize, as we may often observe, a reference to the end of this world.

[2] Lit. country.

[3] *Fravashayō . . . nmānyāo, vīsyāo, zañtumāo, daqyumāo*, Yt. XIII, 21; cf. Yt. XIII, 150–151; Ys. XXVI, 1.

made to the Fravashis of the next-of-kin, to those who had belonged to one's own family. Hence such Fravashis also form for themselves a particular category, having a distinct appellation[1].

The Fravashis of the original members of the tribe or country must have been invoked in general only during offerings and prayer. Reverence may also have been paid to individuals of special eminence, namely, such as had lived in ancient days, and had been glorified by myth and legend. Individual families or clans paid homage probably to their common ancestor, whole tribes to their founders and the establishers of their power. Thus the veneration of the *manes* is accompanied with a cult of heroes.

As the Fravashis are revered within the family, so also do they on their part render to every one of their family or their race help and protection. At the time of the *Hamaspatmaidhaya* festival, when the earth awakens from her winter-sleep and when nature begins to stir with new life, the souls come back from the next world to the earth. For several days they dwell among men; and if they find that their memory still survives among their relatives or descendants, and that their service is neither forgotten nor neglected, then they support them, bestow upon them plenty, prosperity and blessings, pour out in abundance water that moistens their fields, and protect them against the assaults of their enemies.

> 'They, the spirits, fly towards their village at the time of *Hamaspatmaidhaya*, and go round about here for ten nights long. They wish for such help, observing. Who will praise us, who will offer to us?'[2]

> 'They deal out water, each to his own relations, his house, his village, his community, and his country, also saying: "Our own country shall increase in wealth and prosperity!"'

> 'They fight in the combat, each for his land and his

[1] *Fravashayō-nabānazdishtanãm*, Ys. XXIII, 4; XXVI, 6, &c.

[2] Yt. XIII, 49; *vīsādha* must be read in the first line, for in the second it would disturb the metre.

district, as if some land and house have been fixed for them as their dwelling[1].'

In war and battle especially the *manes* manifest their powerful help; and here I believe we directly touch upon a sphere of primitive ideas. They continually make their appearance as powerful and well-armed combatants. In the heat of battle their assistance is invoked. Here they stand by the side of the pious, and help them to gain the victory —

'They, the Fravashis of pious people, convey their utmost assistance in fierce battles[2].'

'They form many armies, and carry hundreds of weapons; they bear banners, the radiant, who in hot fighting hurriedly descend, who vigorously and rapidly give battle to the Dānūs; ye have subdued the opposition of the Tūrānian enemies[3].'

The antiquity of these ideas is attested by the fact that we find in the Rig-veda quite similar invocations and prayers, which the old Indian addresses to the *manes*, the '*Fathers*.' Here, also, they are chiefly esteemed as mighty warriors and as helpers in battle[4].

'Lovely sit together our *Fathers*, dispensing vitality, exposing themselves to peril, full of strength, inexhaustible, with glistening spears, powerful arrows, not lingering, real heroes, ruling far and wide, subduing entire armies:'

'The priestly *Fathers*, loving the Soma-drink, and the

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[1] Yt. XIII, 66–67. We should read *dādhara*. Comp. Skr. *dhr*, which is perhaps construed with the acc. and dat.: 'to persuade anybody to do anything.'

[2] Yt. XIII, 17. *Dāhishta* is derived from *dāha*, formed from root *dā* 'to give.' Comp. Skr. *dāsvat*, *sudās*.

[3] Yt. XIII, 37–38. *Khshtāvi* might be translated by 'a chariot-warrior,' and referred for confirmation to Skr. *sthātr*. However, *khshtāvi* probably means simply 'active, stout, hero' (like *takhma*, *aurva*), to which we would compare *khshtāvant*, an epithet of the moon, perhaps 'the wandering, speedy,' just as *shtum* and *khtūm* 'a hare=the swift one' in the Pāmir dialects (Tomaschek, p. 31).

[4] Kaegi, *Der Rig-veda*, p. 61, notes 346 and 347.

salutary heaven and earth, who have not their equal, and Pushan shall protect us against misfortune. O ye Increasers of Holiness! no malevolent demon shall obtain power over us[1].'

As to the Zoroastrians, however, closer or more remote relationship was not their sole guide in the veneration of departed spirits. They also took into account the attitude, hostile or friendly, which the dead had assumed during their lifetime with respect to the Mazda-religion.

First of all 'the Fravashis of pious men and women' form *one* principal category, and are invoked as such very frequently. This form of invocation alone goes to prove that the unbelieving also owned their Fravashis; yet neither adoration nor offering was ever vouchsafed to them. However, we may admit that they constituted the other principal category.

Among the spirits of the pious, the Fravashis of those that lived and died before the coming of Zarathushtra, and before the announcement of his doctrine[2], form a separate group. I have already observed that reverence for the *manes* naturally leads also to hero-worship. Such religious observances in honour of the heads of tribes or other heroes of antiquity probably existed of old among the different Eastern Irānian families and races, when the reform movement began, which is connected in history with the name of Zarathushtra. It was impossible to eradicate them, because the people strictly adhered to such family customs with singular pertinacity. Nor were these customs even begrudged a place amongst the new doctrines, where room was found for them by regarding those heroes as the

[1] Rig-veda, VI, 75, 9–10.

[2] These are the *fravashayō paoiryō-tkaeshanãm* 'the souls of those who belonged to the first (pre-Zarathushtrian) religion.' A distinction is also to be observed between *tkaẹsha* and *daẹna*!—Yt. XIII, 150: *paoīryãn tkaeshẹ̄ yazamaidẹ̄; nmãnanãmcha vīsãmcha zañtunãmcha daqyunãmcha yōi ãoghare paoiryẹ̄ tkaẹshẹ̄ yazamaidē* 'the earlier pious we revere; those, who were the earlier pious in family, race, tribe or country, we revere.'

followers of an ancient and venerable religion, which preceded Zoroastrism, and to a certain extent paved the way for it

Moreover, later on a distinct position was held by the Fravashis of those pious persons who had been thought worthy to behold the prophet face to face, to hear his doctrine from his own lips, and to receive it from himself. These are the Fravashis of the contemporaries and first adherents of Zarathushtra [1]. They are followed by the great multitude of the Fravashis of those in general who belonged to the Mazdayasnian community, and paid allegiance to the religion of Ahura.

The sphere within which the Fravashis were supposed to have power was a very elastic one. It seems that people always ascribed to them, as time went on, more and more influence and higher faculties. When the souls of the pious, departing in countless multitudes, occupied the apartments of Heaven, their influence was to be felt everywhere. Thus they become at last the supporters and preservers of the whole world, with whose help Ahura Mazda rules over earth and heaven:

> 'Through their power and their glory I uphold firmly the firmament, O Zarathushtra! which, blazing on high, surrounds this earth far away from its side and in a circle [2].'

It is the Fravashis that keep up the sacred stream Ardvisūra, in order that it may flow on with great force and volume. They make the sun, moon, and stars follow their paths [3]; it is they that support the fastnesses of the earth.

> 'Through their power and their glory, O Zarathushtra! I support the wide Earth, created by Ahura, the great, broad one, who is the bearer of much beauty, who bears the whole corporeal world, living and

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[1] *Fravashayō paoiryanãm sāsnō-gūshãm*, 'the Fravashis of the first ones, who listened to the doctrine.' Yt. XIII, 149.

[2] Yt. XIII, 2. The second *yō* is to be extended in order to preserve the metre.

[3] Yt. XIII, 4–8, 16, 57.

dead, and the high mountains, which abound in pastures and fountains[1].'

We have to thank the Fravashis, when children are preserved in the mother's womb, when women are easily delivered, and when excellent sons, who 'are active in council and whose words are heard with pleasure,' rejoice them[2].

And not only does the Ardvi-sūra stand under their protection. It is their principal charge that the precious element of water, the fundamental importance of which for life and cultivation was so very clearly impressed upon the Eastern Irānians, may be well spread over their country; and they also support the other genii, who are entrusted with that work. Hence it is also they who cause the plants to germinate and sprout for the nourishment of men and beasts.

'Through their power and their glory the waters gush forth impetuously from inexhaustible sources. Through their power and their glory plants spring up from the earth from inexhaustible sources. Through their power and their glory winds chasing away clouds blow from inexhaustible sources[3].'

'They can travel to the star *Satavaisa* (*posted*) between earth and heaven, who causes waters to flow, granting prayers, who causes waters to run and plants to germinate for the nourishment of beasts and men, for the maintenance of the Arian countries, for the nourishment of the five kinds of cattle, for the protection of pious men[4].'

In conclusion I must notice yet one point more.

It has been observed that the cult of the Fravashis stands in close connection with the stars and the veneration paid

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[1] Yt. XIII, 9. Cf. Geldner, *Metrik*, § 120.

[2] Yt. XIII, 11, 15, 16; Geldner, *Metrik*, § 109.

[3] Yt. XIII, 14.

[4] Yt. XIII, 43. Regarding the star *Satavaisa*, *vide infra*. It is better to read *pañchō-hayayāo* instead of *pañchō-hyayāo* (cf. the variants in Westergaard) and to trace the word *haya* from rt. *hi* = Skr. *si*.

to them[1]. We have already heard that the stars are under the special protection of the Fravashis. Even the latter are themselves undoubtedly identified with the stars, when it is said of them that, led along the celestial path, they travel on the heights of the firmament[2].

The true home of star-worship is really Mesopotamia; nevertheless I would not suppose that the notion of the Fravashis being stars is due to any Semitic influence. We very often meet with analogies between two different nations in morals, culture, and religion; yet I do not consider it fair to regard such a conformity as the result of borrowing or external influence when no other grounds for such a supposition can be adduced. How easily may such resemblances present themselves in different countries having no mutual dependence on each other, provided that analogous conditions are found to pre-exist in history and nature![3] I mean that the assumption of a borrowing is an explanation which the writer of the history of civilization should adopt very sparingly. So long as we are able to interpret a phenomenon as one produced in an organic manner, we may rest content with the above explanation.

So with the Irānians and Semites. The idea of identifying the souls, that have passed into the heavenly kingdom, with the numberless stars shining and blazing in the firmament is by no means foreign to human nature. A somewhat vivid fancy can take this turn precisely as well in Central Asia as in Asia Minor.

The heavens and stars have certainly not occupied the human mind in Mesopotamia alone. Why should the eyes

[1] Spiegel, *E.A.* vol. ii, p. 98.

[2] Yt. XIII, 42: *mainyu-shūtāo frashūseñti* * *bareshnavō avaṅhē ashnō.*

[3] The idea which I would thereby convey is this, that according to my conviction the Avesta religion must be interpreted wholly from its own teaching. I do not believe that it has borrowed anything from the Semites. It is the special property of the Eastern Irānian nation. Even where apparent or real similarities strike us, we ought to assume them to be a mere accidental coincidence.

of the Arian not have been directed towards them in the low plains near the Oxus and the Jaxartes, where, moreover, the stars glitter with a peculiarly bright lustre through the clear atmosphere of the desert? Why should he not have guessed at the unknown land behind the mysterious space of heaven, wherein the departing soul wanders, and where it shines in the form of a star?

Here I may even call to mind the well-known popular belief of the Germans, according to which the soul, particularly the soul of a child, on separating from the body, is transformed into a star. Finally I may also observe that, according to the Indian idea, the '*Fathers*' are connected with the stars. The '*Fathers*,' says the Rig-veda, 'adorned heaven with stars, as a black horse with pearls[1].'

[1] Rv. X, 68, 11; Justi, *Hdb.* s. v. *fravashi*; Kaegi, *Der Rig-veda*, p. 62, note 348.

# CHAPTER III

## Mental and Moral Culture.

### § 13. *Man in Relation to his Body and Soul.*

The mental and moral gifts of a people, the extent of their general knowledge and their ethics, are an essential constituent of their culture. They are not of less importance for the right understanding of the stage of civilization, which they have reached, than perhaps their social and political institutions. We must, therefore, also briefly discuss those features of Eastern Irānian life.

The spiritual horizon of the Avesta people is naturally still comparatively narrow. Their knowledge is empiric, the sum total of many more or less accidental experiences and observations. An investigation, conscious of its aim, which had for its object the deliverance of the human mind from the fetters of error, we can hardly presuppose.

It is, however, interesting to see how the old Irānian observed with a clear eye and mind the world and its phenomena, and endeavoured to bring into an organized system the observations made regarding the earth and the heavens. Not all the knowledge which we find amongst the Avesta people is self-acquired. We cannot consider as an age of rude unrefinement and ignorance the Arian epoch in which the Indians and the Irānians, still united, formed one and the same nation. From them the Avesta people inherited a great deal, and employed their inherited talents to the greatest advantage. In many cases the very first germs and rudiments of some branch of knowledge may be traced back to the primitive Arian age, but their further cultivation and development belong to the separate history of both the tribes.

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[1] Chapter V, § 35, *Ostīrānische Kultur.*

Hence it is not easy always to distinguish the old property from the newly-acquired possessions. This is, however, so much the less to be regretted, as it most concerns us to indicate the degree of spiritual culture to which the Avesta people had attained, and to fix to a certain extent the limits of their knowledge.

I now commence with the observations which the old Irānian made regarding man himself.

Man consists of body and soul. The body is composed of numerous constituents and members, several of which have their special names[1]. It is, however, to be observed

[1] Body: *kehrpa*; Skr. *krp* 'a handsome look'—*tanu* = Skr. *tanū*.
Bone: *astan*, *asti* = Skr. *asthan*, *asthi*.
Skin: *pãsta* (Tomaschek, *Pamirdialekte*, p. 45.)
Flesh appears to be *kehrpa*; comp. *kerefsh-hvara*.
Marrow, brain: *mazga* = Skr. *majja*.
Blood: *vohuni* = Skr. *vasā*.
Fat: *ūtha* (?)—*pīvaġh* (?)
Head: *sara* = Skr *çiras*, further, Ir. *kameredha*, *vaghdhana*.
Hair: *varesa* (N. Pers. *gurs*);—? *gaesa* (*Hdb. sub voce*).
Beard: *raesha* (cf. Tomaschek, p. 47).
Face and forehead: *ainika* = Skr. *anīka*.
Eye: *akhshi*, *chashman*, *dōithra*; Skr. *akshi*, *chakshman*.
Eyebrows: *brvat* = Skr. *bhrū*.
Nose: *nāoġha* and *nāoġhan*; Skr. *nāsā*.
Mouth: *āoġha* = Skr. *ās*.
Tooth: *dañtan* = Skr. *dantan*.
Tongue: *hizva* = Skr. *jihvā*.
Jaw, cheek: *paitish-qarena* (*ZddmG.* vol. xxxiv, p. 419).
Ear: *gaosha* (also *ghūsh*, *ghokh*, *ghaul*, and *ghowar* are found in Tomaschek's *Pāmirdialekte*, p. 50) corresponds to the Skr. *karṇa*, Ir. *karena*, 'deaf' (just as in Tomaschek's *Pāmirdialekte*, p. 83).
Neck: *grīva* = Skr. *grīvā*.
Back: *parshti* = Skr. *pṛshṭhā*.
Shoulder: *supti* = Skr. *çupti*.
Shoulder, arm-pit: *kasha* = Skr. *kaksha* 'waist.'
Breast: *vara* and *uraġh* = Skr. *uras*; *paitivara* the upper-chest, collar-bone;—*fshtāna* ('nipple' Vd. IX, 19) also for the female-breast, = Skr. *stana*.

that most of these names were not first invented by the Irānians, but are actually of Arian origin. A collection of such names might not be without interest. The Avesta contains particular designations for flesh, skin, and bone, blood, marrow, and fat. Of the bodily parts the following are recognized: the head (including hair and beard), face, and forehead, eye, eyebrows, nose, mouth (with teeth and tongue), chin, cheek, and ear. After these follow: the neck, back, shoulder, armpit, and chest. The female breast is particularly distinguished. Further, the ribs, waist, abdomen, navel, hips, thighs, male and female sexual parts; the arm, elbow, hand, finger, fist; the

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Ribs: *peresu* = Skr *pārçva*.
Waist, the middle part of the body· *maidhya* = Skr. *madhya* (Tomaschek, p 44).
Belly, abdomen *kushi* = Skr. *kukshi* (Tomaschek, p. 55).
Navel: *nabi* = Skr. *nābhi*.
Hips: *sraoni* = Skr. *çroṇi* (*clunes*); also probably *pudenda*. Comp. *perethu-sraoni* = *pṛthu-çroni*.
Thighs: *hakhti* = Skr. *sakthi* and *sakthan*, also translated 'shame.'
*Pudenda*: (a) female: *upasta*, *yaona* = Skr. *upastha*, *yoni*. (b) male: *fravākhsha*, an euphemism for the *membrum virile*, perhaps 'a branch, a sprout,' *ZddmG*. vol. xxxiv, p. 419; like German 'Rute' and Indian *vaitasa* 'reed.'
Arm: *bāzu* = Skr. *bāhu*; *arema* (Tomaschek, p. 53).
Hand: *zasta* = Skr. *hasta*.
Elbows: *bare*sh*ti* (Tomaschek, p. 53).
Finger: *erezu* 'straight'; *tbishi* 'finger-joint';—*angu*sh*ta* 'thumb' = Skr. *angushṭha*.
Fist: *mu*sh*ti* = Skr. *mushti*.
Right and left: *dashina*, havya = Skr. *dakshina*, *savya*.
The bone from the thigh up to the knee: *rāna*.
Knee: *zhnu*—Skr. *jānu*.
The calf of the leg: *aschu*.
The shinbone: *zanga*—Skr. *janghā*.
Foot: *pādha* = Skr. *pāda*.
The instep: *frabda* = Skr. *prapada*.
The sole: *hakha*.
The heel: *pāshna* = Skr. *pārshṇi*.
Heart: *zaredhaya* = Skr. *hṛdaya*.
Lungs: *sushi* (Tomaschek, p. 54).

upper-thigh, knee, calf of the leg, shinbone, foot, the instep, the sole, and heel. Besides, I remark the distinction between right and left; and lastly, the names of the two internal organs, the heart and the lungs.

The Doctrine of the Soul in the Avesta, is not to be called quite simple and wholly primitive. At all events it presupposes a certain amount of philosophical speculation. It rests upon the observation that the spiritual activity of man expresses itself in manifold ways[1], and upon the conclusion thence inferred, that in man a multiplicity of forces exist, of which each one has its own well-defined sphere of action. Besides, it is a specific production of the Irānian mind, and hardly admits, in its very essence, of any connection with pre-existing ideas and doctrines.

There are generally five, less frequently four, spiritual faculties, which are supposed to be innate in the human body. They are, according to their nature and efficacy, entirely different from one another, partly without beginning and without end, partly transitory, partly not existing from eternity, yet certainly continuing for ever. They are called (1) *Conscience*, (2) *Vital Force*, (3) *Soul* as a moral power, (4) *Spirit*, in the sense of consciousness and intelligence, and (5) '*Fravashi*.' Instead of the two first names there is also now and then used a special expression, which, however, does not probably denote anything more than the principle of life[2].

[1] *Vide supra* p. 84.

[2] The Avesta expressions are *daęna, aĝhu, urvan, baodhaĝh, fravashi*, Ys. XXVI, 4 and 6; Yt. XIII, 149. Instead of *daena* and *aĝhu* there stands in Ys. LV, 1. *tēvishi* from the root *tu* 'to be strong.' Besides, it is probably only a synonym for *aĝhu* and *daena* 'conscience,' which does not mean a force peculiarly belonging to man, but rather a force working upon him from without, and is in fact omitted in the passage concerned. In later times the well-known passage of the Sadder-Bundehesh (in Spiegel's *Trad. Lit.* pp. 172–176), which discusses the Parsee doctrine of the soul and harmonizes most completely with the ideas of the Avesta, was naturally and especially made use of to represent this idea. In this passage are enumerated the five faculties, *jān, akhō, rvān, bōi* and *frōhar*. The

*Conscience* is a divine power, which exists from eternity to eternity independently of the mortal body, an inherent voice which tells man immediately after every action, whether that action was good or bad, and accordingly it praises or accuses him. Its purity and sanctity cannot be affected by the sins of man, since it has no part in them. As long as it is possible, conscience restrains man from guilt and sin; when it is no longer able to do so, it sorrowfully abandons him and returns to heaven. This doctrine is based undoubtedly on the experience that man is able, in course of time, to drown the warning voice within and to lose his conscience.

Of course the continuance of its existence is by no means prejudiced by the death of man. It is a characteristic of its nature that, according to the Avesta, it still exercises its influence after death on the soul wandering into the next world. To the soul of the pious man it appears personified in the form of a charming maiden, who hails him as happy on account of good actions done during life; but to that of the impious man it appears in the form of an ugly hag, who upbraids him with reproachful words for all his sins, and bitterly accuses him on account of them[1].

By this it is not meant that conscience is not unchanging, but only that it appears in one form to the one and in another form to the other. It terrifies, torments and alarms the wicked, but on the good it confers joyfulness and peaceful serenity.

To the *Vital Power* it is appointed to find and watch over the corporeal functions of man. It originates only with the body and perishes with the matter[2]. It has

last three correspond with the last three soul-powers of the Avesta, not merely in name, as the description which follows in the Sadder proves, but in their essence; *jān* is, however, undoubtedly parallel to Av. *ağhu*, and *akhō* to *daena*.

[1] *Vide supra* pp. 102, 104–105.

[2] [The Avesta does not say anything with reference to the non-existence of *ağhu* after death. On the contrary we praise the *ağhu* of every pious Mazdayasna after his departure from this world. Comp. Ys. XXVI, 4. *Vide* my paper in the *Bombay Gazette* of

therefore a beginning as well as an end, and occupies in consequence the lowest rank among the faculties of the soul.

The *Spirit* is the intellectual power in man: his consciousness, intelligence and reason[1]. If death be regarded as a separation of the body and the spirit, the latter must have a somewhat general signification. The business of the spirit is to rule over the memory, understanding and judgment, in order that each may perform its duty and co-operate for the welfare of the body. It appears to come into being first with the body, but after death to unite with the soul and the Fravashi, and to accompany them into the next world.

The *Soul* has to choose for itself between good and evil. It has a moral power by virtue of which man possesses a moral freedom of election. It *should* of course make choice of what is good, it *can*, however, turn also towards evil. For this reason it must account after death, together with the spirit, for its behaviour on earth[2], and, according to the result of the judgment, it receives either eternal bliss or

Nov. 3, 1882, on the 'Avesta Doctrine regarding the Body and Soul.'

With reference to this note Dr. E. W. West remarks in a letter to Dastur Peshutonji:—'As to *anghu* your son rightly corrects Dr. Geiger, as the word evidently means both bodily and spiritual life.—What life is we do not know, but even in its common acceptation it seems to be some spiritual property that becomes manifest in the body; whether it begins and ends with the body we do not yet know, as hitherto we have found no means of maintaining the sensible existence of the one without the other, but we can conceive that such is possible. These, however, are matters of speculation in which I do not often indulge; but I am fully persuaded that if mankind ever discover anything certain about the spiritual world, by means of their own researches, they will have to change all their past notions regarding psychology and philosophy.']

[1] Hence *baodhō-varshta* is an act perpetrated with consciousness and deliberation (Vd. VII, 38). Comp. also *baodhō-vīdhvāo · chichithwāo baodhaghaitīm vīthushīm* (Vd. XVIII, 67).—A wound which deprives one of consciousness (not of life, as Justi understands), is called *snatha · frazā-baodhagh* (Vd. IV, 40, &c).

[2] Vd. XIX, 29; *vide supra* pp. 102, 104, 105.

damnation. Frequently, 'soul' is the designation for all the immortal powers of man that have passed into the other world.

Lastly, with the spirit and the soul is united after death the *Fravashi*, in order to form from that time an indivisible whole. The Fravashi, however, appears to be by its nature not only imperishable like the conscience, but also without beginning. It would be best to consider it as a tutelary spirit that watches over man and protects him. Hence the Fravashis and the *manes* or spirits of the dead are almost identical; for that reason there are also Fravashis of those who are yet unborn[1]. It is only for the time during which a man lives that the guardian spirit descends from heaven on this earth and accompanies him on his way . . . .

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## § 14. *The World.*

THIS section will treat of the knowledge and ideas which the Avesta people had of this visible world, its structure and organization. We may begin by quoting a few strophes of an old hymn which we cannot but think one of the most poetical passages in the Gāthās. They show us that the pious mind of the old Irānian beheld in all the phenomena and wonders of nature the ever-working power of the Deity:

'That I ask of Thee, give me truly answer, O Ahura:
Who was the progenitor and father of order from the beginning?
Who made their courses to the Sun and Stars?
Who made it that the moon waxes and wanes, who but Thee?
This, O Mazda, and other things I long to know!'
'That I ask of Thee, give me truly answer, O Ahura:
Who then kept the earth and the clouds above,
That they fall not? Who made the water and the plants?

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[1] *Vide supra* p. 113.

Who gave their swiftness to the wind and the fogs?
Who is, O Mazda, the creator of the pious mind?'
'That I ask of Thee, give me truly answer, O Ahura:
Who is the artificer that made light and darkness?
Who is the artist that made sleep and wakefulness?
Who made the dawns, the mid-days and the evenings,
Which remind the careful of their duties[1]?'

The earth, with which I begin, is the dwelling-place of man and the other animals: bearing and feeding everything, she is the great mother, the bounteous one from whose lap trees and herbs grow up to give nourishment to all creatures[2].

As to its shape, it was thought, it seems, to be a large disc. That is meant, in my opinion, by the epithets 'wide,' 'broad,' 'round,' 'far-limited[3].' In old Indian the earth is likewise called 'the wide.'

The special guardianship of the earth is confided to Spentā Ārmati, a female genius of temperate and devout

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[1] Ys. XLIV, 3-5.

*Tat thwā · peresā eresh mōi · vaochā · Ahurā*
*Kasnā · zāthā patā · ashahyā · paouruyō?*
*Kasnā · qeñg · staremchā · dāt advānem?*
*Ke · yā · māo · ukhshyēiti · nerefsaiti thwat?*
*Tā · chit · Mazdā · vasemī · anyāchā · vīduyē!*
*Tat · thwā · peresā · eresh · mōi · vaochā · Ahurā ·*
*Kasnā · deretā · zāmchā · adenabāoschā ·*
*Avapastōish? ke apō · urvarāoschā ·*
*Ke · vātāish · dvānmaibyaschā · yaoget · āsū?*
*Kasnā · vaṅheush · Mazdā dāmish · manaṅhō?*
*Tat · thwā · peresā · eresh · mōi · vaochā · Ahurā:*
*Ke · hvāpāo · raochāoschā · dāt · temāoschā?*
*Ke · hvāpāo · qafnemchā · dāt · zaēmāchā?*
*Ke · yā · ushāo · arem-pithwā · khshapāchā ·*
*Yā · manōthrīsh · chazdoṅhvañtem · arethahyā?*

[2] *Yā · nāo baraiti* 'which bears (feeds) us,' Ys. XIII, 1 (cf. the significations 'to feed,' 'to foment,' 'to keep up,' for Skr. *bhar*); *berethri* 'bearer,' 'mother,' = Skr. *bhartṛ*.—*Zām · hudhāoṅhem* (= Skr. *sudās*) *yazamaidē*, Ys. XVI, 6.

[3] *Perethu* (cf. Skr. *pṛthivī* 'earth'), *pathana*, *skarena* (in the Pamir dialects *kard* and *cherd* mean 'curved,') and *dūraē-pāra*.

mind[1]. What kind of connection there existed between the moral and material functions of Ārmati cannot easily be stated.

Certainly, she is the genius of the earth, whenever she is called the dwelling-place and home of mankind[2]. It is to her that Yima applies, as the earth, which he inhabits, has no longer sufficient space for man and beasts praying

> 'For love's sake, O Spentā Ārmati, widen and extend thyself, thou mother of flocks and herds and human-kind!'

And Yima extended the earth, so that it was larger by one-third than before, and there spread over it flocks and herds and men to their pleasure, as fully as they listed[3].

The first attempts at dividing and classifying the surface of the earth, according to certain principles, are to be sought for in an ante-Irānian period. In the Avesta the earth is considered either tripartite or septempartite. Both methods of division are met with also amongst the Indians, although there exist several discrepancies in the details[4].

If the Avesta speaks of the three thirds of the earth, the fact recalls vividly to our minds the 'three earths' of the Rig-veda, the superior, the intermediate, and the inferior[5]. Three strata or layers, one lying above the other, are said to be meant by this. That is certainly not the meaning of the Avesta. In my opinion it means nothing more than a quite primitive division of the earth into three zones;

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[1] The opposite of *ārmaiti* (from *aram*=Skr. *alam*, + *maiti* from the rt. *man* 'to think') is, (Ys LX, 5), *taromaiti* 'intemperate thinking, pride, haughtiness.' In like manner in Ys. XLV, 11 *tarēm · māsta* and *arēm · mainyātā* are opposed to each other. The reader may compare also *taramaitish* *qaetēush* 'disregard of relationship.' In the Gāthās *āramaitish* (=Skr *aramati*) is tetrasyllabic.

[2] Ys XVI, 10; *yazamaidē thwām maethanem yām ārmaitim. spentām.*

[3] Vd. II, 10 seq.

[4] Spiegel, *E.A.* vol. i, p. 88 seq; Justi, *Beiträge*, at the beginning; Justi, *Bundehesh*, Glossary, s. v. *Kēshvar*.

[5] Zimmer, *AiL.* p. 357.

such a division might easily be suggested or occasioned by the nature of the country.

The intermediate zone of the earth is that in which the Avesta people live. Here they wage their wars against the hereditary enemies of their tribe, the Tūrānians[1]. To the North of them extend the inaccessible deserts and steppes near the Aral and Caspian Seas, from which those Tūrānians burst forth to devastate the Arian countries in their inroads. They may be supposed to form the second, or Northern, third of the earth. South of the Irānian territory are situated the hot sand and salt steppes of Central Persia, of Baluchistān, and the unknown India—the last third, or the Southern zone.

A more complicated division of the earth is that into seven *Karshvars*, since it seems to be in contradiction with what we have just mentioned. It is certainly very old, for the Gāthās already speak of the 'septempartite earth[2]' According to the statements of later Parsee Scriptures, the seven Kēshvars are to be considered as completely disconnected parts of the earth. Between them there flows the ocean, so that it is impossible, as stated in several passages, to pass from one Kēshvar to another[3]. Mythological explanations of the origin of the Kēshvars are not wanting.

The coincidence of this doctrine with the Indian one touching the seven *Dvipas*, as met with in the *Purānas*, is self-evident. It did not also escape the notice of the Parsees, as we may see from traditional Sanskrit translations of Zoroastrian documents[4].

But incongruities are not wanting The Dvipas form concentric rings, which, separated by the ocean, surround Jambu Dvipa, which is situated in the centre. According

[1] Ys. XI, 7: 'May not Hauma fetter thee, as he fettered the pernicious Frangrasyan of Tūrān, the iron-clad, in the middle third of the earth.'

[2] Ys. XXXII, 3: *būmi · haptāiti*.

[3] Cf. e.g. Vd. I, 4 of the Pahlavi Translation; Bdh. XXI, 2–3.

[4] Neriosengh, the translator of the Yasna, consistently renders *Karshvare* by *Dvīpa*, and especially *Qaniratha* by *Jambudvīpa* (cf. also West, *Mkh. s. v. Kēshvar*.

to the Irānian view, the *Karshvar Qaniratha* is likewise situated in the centre of the rest. They form no concentric circles, but each of them is a peculiar, individual space, and so they group themselves round Qaniratha. Two, *Voru-barshti* and *Voru-zarshti*, lie in the North, two, *Vidadhafshu* and *Fradadhafshu*, in the South, *Savahi* and *Arzahi* in the East and West

We shall, I think, arrive at a rather accurate notion of the original conception by looking upon it in the simplest possible light. Perhaps it was remodelled under the actual influence of India and did not receive the shape which appears in the later Scriptures of the Parsees, save by contact with the doctrine of the Dvipas. In the Avesta the Karshvars certainly were nothing but a progression and differentiation of the tripartite division of the earth. The intermediate Karshvar Qaniratha coincides more or less with the intermediate zone, and is reputed to be the home of Irānian human-kind[1]. The Northern and the Southern zones are each separated into two halves; the Karshvar in the East and that in the West are new additions. By this I do not mean to say that the tripartition is an older, the septempartition a later notion; both may have grown up together, and both form more or less definite conceptions of the same object

In the Avesta the expression, 'the seven Karshvars,' is nothing but a comprehensive view of the whole earth, in the same way as the three thirds[2]. It seems also to presuppose the possibility of communication between the single parts of the earth. At least utterance is given to the desire that the religion of Zarathushtra may spread over the seven Karshvars of the earth[3]. It would be necessary to take refuge in a rather artificial interpretation,

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[1] Hence *Qaniratha* alone is combined with *imat* 'this,' while all other *Karshvars* with *avat* 'that;' Vd. XIX, 39.

[2] Cf. e.g. Yt. X, 15–16.

[3] Yt. XIII, 94: *idha · apãm · vījasaiti* vaghvi · daęna · Māzda-yasnish** (*vīspāish*) *avi karshvãn yāish hapta. Vide* Geldner, *Metrik*, § 131.

were we to think of any other mode of propagation of the Zoroastrian doctrine than that by the natural means of the proselytizing labour of believing priests.

I therefore think that by Qaniratha is meant the country inhabited by the Irānian tribes, and, by the other names, the adjacent territories of foreign nations in the North, South, West, and East.

Above the three thirds of the earth spreads the *firmament* or *sky*, the dwelling-place of the clouds and fogs, and above these *heaven* properly so called. It is propped up by the Fravashis, to whose care the order of the world is confided, that it may not break in pieces[1]. It is the home of the divine beings, as the earth is the home of men. Here we must suppose the regions of Paradise must be looked for, the highest of which is the *Garō-nmāna*, the resplendent mansion of Ahura Mazda and of the other genii and happy spirits.

Heaven, as its name in the Avesta implies, was thought to be made of stone. It is also called 'the swift,' on account of the rapid rotation and revolution of the firmament[2]. The later Scriptures of the Parsees make a difference between an inner and an outer Heaven. The latter is a wall built of blue stone, and serves to keep off the evil spirits. To the former, which is in continual motion, the stars are fixed[3].

A distinction of the different points of the compass was not unknown to the Avesta people. The Eastern Irānians named them entirely as the Indians did, facing the rising sun. So the East is called the anterior, the West the posterior region; the South is the region on the right, the North that on the left hand[4]. According to another

[1] Yt XIII, 2–3; see above, p. 117.

[2] *Asman* 'stone' and *thwāsha* 'swift,' from rt. *thwakhsh* 'to hasten.'

[3] I do not know whether this difference between *asman* and *thwāsha*, an outer and inner heaven, can be recognized as early as in the Avesta. It must be observed that here the former also is said to be star-covered, which certainly contradicts the later belief.

[4] 'South-wind' *dashināt · hacha* Vd. III, 42; 'North-west wind'

terminology, the Avesta people designated the East as the region of the 'rising (sun),' the West as that of the 'setting (sun),' the North, which is regarded as the domain of all evil and hurtful powers, as the 'starless region,' and the South, like the peoples of the Occident, as 'mid-day [1].'

Among the celestial orbs, the Sun[2], the day-star, is venerated most. The Irānian beholds in light the symbol of moral purity and the peculiar sphere for celestial genii to work in. The Sun, therefore, as the bearer of light, is to be regarded as a prominently powerful champion against demons.

> 'If the sun does not rise, then the demons would destroy all things that exist in the seven parts of the earth, nor are the heavenly spirits in this visible world able to find means of defence or resistance [3].'

As the eye is the light of the human body, so is the sun the light of heaven or its eye. But the bright clear heaven (or sky) was in the old popular religion personified in the Highest God, Ahura Mazda. Therefore, in the Avesta the sun is called His eye[4]. Such symbols of nature are rare in the Avesta religion, by far rarer, without doubt, than in the Vedic. It is, therefore, the more gratifying to find both agreeing in this respect. But in the Rig-veda the sun is called the eye of Varuna, and this proves to us,

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*aparō* (lying behind)-*apākhtarō* (northern)-*vātō* Yt. III, 17, *vide* p 141 of *OKA*. note 3. Similarly *pouru-apākhtara*. Hence Mithra, the yazata of light, closely connected with the wandering sun, is said to drive along the right side of the earth, that is to say, on the southern part of the sky. Yt. X, 99

[1] *Ushastara* (from *ushaġh*=Skr. *ushas*), *daoshatara* (from *daosha*= *doshā* 'evening'); *apākhtara* (from *apa*+*akhtara* 'star'); *rapithwa* Vd. II, 10 (*rapithwitara* · *naema* Afr. III, 6; Yt. XXII, 7).

[2] *Hvare*= Skr. *svar*, *sūrya*; *hvare-khshaetem*=N. Pers. *khurshēd*. Spiegel, *E.A.* vol. ii, p. 66.

[3] Ys. VI, 3. In the last line of this verse, I think, *naędha* · *pairishtām* · *vīdheñti* must be read.

[4] Ys. I, 11, *hvarecha* · *khshaetahē* · *aurvat-aspahē* · *dōithrahē* · *Ahurahē Mazdāo*.

amongst other things, the fact that at least substantially Ahura and Varuna correspond with each other, and both originate from the same deity of the Arian period[1].

The sun is also called the body of Ahura Mazda. God is essentially light itself. Him the human eye cannot perceive, but it can see the sun, in which the light is embodied[2]. No special explanation is necessary wherever the sun appears as the enemy of thieves and heretics, and similar wicked beings, that love deeds of gloom and darkness[3].

The daily journey of the sun round about the heavenly vault from East to West made of course a deep impression on the minds of the old Irānians. It was a superhuman, a divine operation. He was, therefore, thought, especially among the common people, to be a bright-sparkling chariot, drawn by heavenly horses[4].

Mithra also, the *yazata* of the rising daylight, rides on horses and chariots. Four bright horses are yoked to his car. So he mounts over the bordering eastern mountain ranges, the *Hara-berzati*, and first embracing with his light the highest summits, he irradiates the whole Arian land.

The notion that the *yazatas* of the sun and light drive in chariots, must be traced to the remotest antiquity. I will only mention Eos and Helios, and will recall to your minds the Indian myths. Both Açvins, the light-bearers of the morning, the sons of heaven, ride on horses. A splendidly decorated car drawn by white horses and oxen carries up to heaven the Ushas, or Dawn, until at length the Sūrya, the flaming god of the sun, appears himself every day driving his light-coloured horses along the wide vault of heaven[5].

A friendship, a closer connection, exists between the Sun and the Moon[6]. If that is the star of the day, this is the

[1] *Rv.* I, 50, 6; I, 115, 1; VI, 51, 1; VII, 63, 1.—Darmesteter, *Ormazd et Ahriman*, p. 43 seq., particularly p. 50.

[2] Ys. XXXVI, 6; LVIII, 8. [3] Yt. VI, 4.

[4] Hence the epithet *aurvat-aspa* 'with swift horses,' Vd. XXI, 5, Ys. XVI, 4; Yt. VI, 1, XII, 34.

[5] *Kaegi, Der Rig-veda* p. 35 seq.

[6] Moon *maogh;—yazāi · hakhedhremcha · yat · asti · hakhedhranãm ·*

luminary of the night. Her waxing and waning is the most striking phenomenon connected with the moon. Fifteen days, it is said, the moon grows, and fifteen days she diminishes[1]. Speaking correctly, the time from one phase of the moon to the return of the same phase is known to amount to twenty-nine days and twelve and three-quarter hours (the synodical month) The Avesta, therefore, distinguishes between full-moon and new-moon[2]. That is certainly the most primitive form of chronology, which combines the calculation by days with the calculation by the changes of the moon. The time which elapses between two consecutive full-moon or new-moon days is fixed at thirty days in round numbers and divided into two halves, the period of increasing and that of decreasing.

A mysterious influence on the growth of plants was ascribed to the moon. When her mild light is shining in spring, gold-coloured herbs grow up from the earth[3]. It may be that the epithet 'containing cattle-seed[4],' which is often applied to the moon, denotes an analogous influence on the fertility and increase of herds. The later tradition, it is true, explains the name in a rationalistic way by relating that, after the death of the primeval ox, the moon preserved his seed and procreated by means of it the different kinds of cattle.

The Stars in their regular unchangeable course are the very prototype of cosmic order. For this reason they are said to be the garment of Asha-vahishta, the genius of the order of the world[5].

The planets are reputed wicked hurtful stars, since they seem to mar the cosmic order. The army of fixed stars is arrayed in the sky to fight them. That the spirits of dead men were brought into contact with the stars has been stated already before.

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*vahishtem · añtare · māoghemcha hvarecha*—Yt. VI, 5. About the veneration of the moon *vide* Spiegel, *E. A.* vol. ii, p. 70

[1] Yt VII, 2.

[2] *Añtare-māoghāoscha · perenō-māoghāoscha*, Yt. VII, 4.

[3] Yt. VII, 4.

[4] *Gao-chithra*, Yt. VII, 1, 3, &c.

[5] Yt. III, 1.

The most important and powerful stars or constellations are Tishtrya, Satavaisa, the Pleiades, and the star Vanat 'the victorious.' The first is reckoned lord of the Eastern quarter of the heavens, the second lord of the West, the third of the North, and the fourth of the South. The Pleiades are seldom mentioned in the Avesta [1]; in the later Scriptures of the Parsees they appear as the noblest and first of all constellations [2]. Corresponding with them is the Vanat, that dominates the southern sky. I take it to be Fomalhaut in the constellation Pisces. It is believed to be the chief enemy of the Khrafstra, the whole vermin-kind, which were created by the Evil Spirit for the punishment of man [3].

Tishtrya is, beyond all doubt, Sirius, the dog-star. Plutarch bears testimony that it was held in high veneration by the Persians [4]. It is the 'first' of all constellations [5], the brilliant, bright star, that does not remain visible to the eye during the whole year. We shall best understand the Tishtrya-myths by calling to mind the times at which Sirius rises and sets.

In latitude 38° North—approximately the latitude of Moru (Merv)—the following are the results obtained for Sirius in the year 1000 before Christ [6]:

| | | | | |
|---|---|---|---|---|
| 1st May, | rises: | 8h. 50m. forenoon; | sets: | 6h. 54m. evening. |
| 1st June | „ | 6h. 50m. „ | „ | 4h 54m. afternoon |
| 1st July | „ | 4h. 50m. „ | „ | 2h. 54m. „ |
| 1st Aug. | „ | 2h. 50m. night; | „ | 12h. 54m. mid-day. |
| 1st Sept. | „ | 12h. 50m. „ | „ | 10h. 54m. forenoon &c. |

Thus Sirius rises, between June and July, at the same

[1] Yt. XII, 28, XIII, 60: *hapto-iringa*=(*sapta*) *ṛkshāḥ* in the Rig-veda.

[2] So in *Mkh.*; cf. also Spiegel, *E.A*, vol. ii, p. 74, note 1.

[3] Cf. Yt. 20.

[4] *De Iside* 47; ἕνα δ' ἀστέρα οἷον φύλακα καὶ προόπτην ἐγκατέστησε τὸν Σείριον. I here renounce the quite erroneous identification of Tishtrya with the morning-star (*vide* my *Handbuch*, p. 134).

[5] *Pouirya*—Yt. VIII, 12, if this does not designate a peculiar star.

[6] I owe these calculations to the kindness of Professor Noether, of Erlangen.

time with the sun, becomes first visible in the morning sky towards the end of July, appears in August before sunrise in full brightness, and remains visible the whole night during November.

Quite similar results appear at the same latitude for the year 650 before Christ; but Sirius stays 4 minutes longer above the horizon; it rises, in general, later by 13 minutes and sets 17 minutes later:

| | | | | |
|---|---|---|---|---|
| 1st May, | rises: | 9h. 3m. forenoon, | sets: | 7h. 11m evening. |
| 1st June | " | 7h. 3m. " | " | 5h. 11m. " |
| 1st July | " | 5h. 3m. " | " | 3h. 11m. afternoon. |
| 1st Aug. | " | 3h. 3m. " | " | 1h. 11m. " |
| 1st Sept. | " | 1h. 3m. night; | " | 11h. 11m. midday. |
| 1st Dec | " | 7h. 3m. evening; | " | 5h. 11m morning. |

In the calendar of the Avesta to Tishtrya is dedicated the fourth month, which falls between June and July, exactly during the time in which Sirius rises together with the sun. Under these circumstances the insertion of the Tishtrya-month cannot be regarded as a mere accident[1].

The veneration of Sirius, which, being the brightest star in the Northern sky, attracted at all times the attention of man, is apparently founded on the fact, that it shines in the firmament just at the time of the greatest solar heat, and that this heat diminishes in proportion as Sirius remains longer above the horizon, and as the time of his rising advances. This coincidence was in course of time looked upon as that of cause and effect. Sirius is reputed an adversary of the demons, who create the insupportable heat of the Irānian summer. From this star the enlivening rains are expected Men and beasts await and yearn for its coming[2]:

> 'To Tishtrya, the bright sparkling star, we bring veneration:
>
> 'Whom the waters remember, stagnant and flowing waters, they that are in fountains and streams, the raining and pond-waters.

[1] Cf. Roth, *ZddmG.* vol. xxxiv, p. 713.

[2] Yt. VIII, 48; Cf. Yt. VIII, 5.

'When will arise for us Tishtrya, the shining, sparkling? When will the horse-strong fountains abound with running waters?

'The beauteous; that over lands and fields and over meadows are streaming. Then the sprouts of herbs will rise with vigorous growth[1].'

The central point of the Tishtrya-myth is his combat against the demon Apausha 'the burner.' Ten nights, so runs the legend[2], Tishtrya makes his appearance in the shape of a youth of fifteen, ten nights in the shape of a gold-horned bull, and ten nights in that of a fallow-horse. Then his adversary Apausha comes to meet him in the form of a black horse, hairless on his tail, back and ears. Three days and three nights they fight with each other. At first Tishtrya is vanquished. But at last he succeeds, with the help of Ahura Mazda, in conquering and driving away his antagonist.

This legend, too, is explained by the real conditions of Sirius. It is not immediately after the arrival of this star that the heat diminishes; on the contrary, just at this time, at the end of July and the beginning of August, it reaches its highest degree. Vegetation grows dry and colourless, the earth 'bare' and 'black,' moisture is more or less evaporated. This is the time, during which Tishtrya is not yet strong enough to vie with his adversary. Its duration is 30 days, at the termination of which begins the three days' battle, that ends with Apausha's being routed. So the diminution of heat falls, as it does in reality, in the last days of August.

The Parikas are prominent adversaries of Tishtrya. They, too, were represented as superhuman beings and were specially connected with the shooting-stars. Tishtrya, therefore, is said to conquer the Parikas, that fly about between heaven and earth as worm-stars[3].

[1] Yt. VIII, 41-42. Geldner, *Metrik*, § 96. I have accepted Geldner's correction *aiwighzhārān* in the place of *aiwighzhārem* (variant *aiwighzhārām*) in the second strophe.

[2] Yt. VIII, 13-34.

[3] Yt VIII. 8.

The Evil Spirit has created the Parikas, that they may offer resistance to the rain-bestowing stars One of them is peculiarly denominated the Parika of Scarcity[1].

When Tishtrya has routed wicked spirits,

> 'Then come forth the rainclouds bearing fertilizing water, clouds full of far-flying vapours, that are spreading far and wide, blessing the seven parts of the earth[2].'

This tradition, like the foregoing, finds its explanation in real phenomena. At the very time of the greatest heat, on the tenth of August, the earth traverses the meteoric swarm of the Perseides, and this night particularly abounds in shooting-stars. This phenomenon excited of course the liveliest interest, the more so as there existed at that time no second annual incident of the kind to claim attention. For the November swarm of the Leonides was, according to Leverrier's calculation, not before the year 126 after Christ compelled to enter into our solar system[3].

It was natural to think that the fall of meteors and the heat of the dog-days had some causal connection. But, since the appearance of Sirius falls in that period, the antagonism between this and the meteors, or as it is expressed in the dialect of mythology, between Tishtrya and the Parikas, was naturally suggested.

The companion of Tishtrya and his help-mate is the star Satavaisa. They work together principally in distributing moisture over the earth. The Fravashis let him wander between heaven and earth, that he may refresh, by the moisture of rain, men and beasts and plants[4]. Conformably to the opinion of the Parsees, he is lord and ruler of the Western sky, as Tishtrya is of the Eastern.

But here arises a difficulty. An explanation may easily be given of the popular opinion, which attributes the

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1 *Pairika · duzhyâirya.* Yt. VIII, 51.

2 Yt. VIII, 40. *Urvâitî*sh should be read *uru-vâitî*sh as Geldner supposes (*Metrik*, § 57).

3 Cf. Peschel, *Physische Erdkunde*, I, p. 114 seq.

4 Yt. XIII, 43; see above, p. 118.

government of the South and the North each to a fixed star, according to its course. But how people happened to imagine that a star was reigning in the East or West is less easy to explain.

The idea cannot possibly have had its origin in observations of the general course of the star in question. It must rather start from a determined period of the year, during which this star is seen exactly in the East and correspondingly in the West. One thing must be granted : Satavaisa must be a star that, in its setting, is nearer the equator than either of the poles, consequently between North-West and South-East. Otherwise it could not be called 'Regent of the West.' It is, likewise, true that Sirius rises in the South-East.

Since Satavaisa is in every regard the counterpart of Tishtrya, I must return to it in order to define the latter. The time at which Tishtrya-Sirius develops its chief activity is Midsummer, or rather August. In this month it shines before sunrise in the Eastern sky

We must, therefore, conclude that if Satavaisa is the counterpart of Tishtrya, it must stand at the same time, the beginning of August, *after sunset* in the West, in order to be reputed ruler of the West. So we arrive at the conclusion that Satavaisa must be identified with the star Antares in *Scorpio*[1]. Rising, in fact, on the first of August, between 1 and 2 in the afternoon, it is at 9 o'clock in the evening above the South-Western horizon and sets about an hour later.

But I think that Antares is no fit ruler of the West. At 38° North Latitude its course is too much in the South Its culmination is only about 26 degrees above the horizon. We would rather give him a power similar to that of Fomalhaut which culminates at about 22 degrees.

The star Arcturus of *Bootes* seems to be more to our purpose. It is on the first of August at seven o'clock in the evening West-to-North in the sky and sets between 10 and 11. It culminates at 74 degrees more or less.

[1] So West, 'Pahlavi Texts,' part 1, pp. 12–13 note.

In identifying Satavaisa with Antares or Arcturus, we always observe that at the time when it declines in the West, Fomalhaut is on the South-Eastern horizon, and Ursa Major low in the North-North-West

But in determining Satavaisa I prefer by all means starting from another point of view. If Sirius is ruler of the East and Satavaisa of the West, both must stand at *the same time* in the sky, the former towards morning, the latter towards evening. So we must find for Satavaisa a star that shines in the Western sky *before sunrise in the beginning of August*. If this hypothesis is correct, Satavaisa and Wega in the constellation of Lyra must be one and the same star.

Wega rises on the 1st of August about noon and sets at four in the morning. So it is visible for a time together with Sirius. Hence results the surprising combination, that during this time Sirius is standing in the South-East, Fomalhaut in the South-West, Wega in the North-West near the horizon, and the stars Mizar and Alioth, $\epsilon$ and $\zeta$ of Ursa Major, almost exactly in the North Thus we have four governors of the four points of the compass at the same time in the firmament, and the whole doctrine concerning them clears up in a most simple way from real circumstances, when we take as a starting-point the period in which Sirius, without doubt the most prominent of the four, shows its greatest activity and efficacy.

We can now understand that Tishtrya and Satavaisa are a closely connected couple. Sirius and Wega are two stars that may be said to relieve each other. When the former first appears in the morning sky, the latter is visible during the whole night. The more Sirius increases in brilliancy and the longer he remains in the sky, the more Wega decreases. Finally, on the first of December, when Sirius rises at seven in the evening and so remains visible all night, Wega disappears only an hour later below the North-Western horizon.

I shall not conclude without mentioning that in the names *Tishtryeni* and *Pauryeni* greater groups of stars are comprised[1]. Evidently they are in close correlation to *Tishtrya*

[1] Yt. VIII, 12.

or *Paurya*, by which denomination the same star is probably meant; perhaps they are stars in his immediate neighbourhood. We must further remark that the distribution of water on the earth and the fostering of vegetation is not, according to the view of the Avesta, the exclusive charge and duty of Tishtrya and Satavaisa. They are aided in this by a whole body of stars, from which, as the Avesta says, 'the water comes and the plants and the (fertile) earth [1].'

## § 15. *Chronology and Calendar.*

IN describing the climatic conditions prevailing in the dwelling-place of the Avesta people I remarked that, strictly speaking, they divided their year into two parts only, summer and winter [2]. Thus it is that we meet with a two-fold calculation, by years and half-years [3]. Now I shall demonstrate below that this fact is involved in the whole arrangement of the calendar.

Though the dialect of the Avesta must be supposed to have some distinct name for spring and originally one also for the latter part of autumn [4], yet these periods of transition are so short in Eastern Irān, that they were entirely lost and merged in summer and winter.

The most prominent phenomenon was certainly the winter with its intense and lasting cold. Winter, therefore, is used instead of 'year' in the dialect of the Avesta. What

[1] *Stārō · āfshchithra · urvarō-chithra · zemaschithra.*

[2] [Vide § 21 of *OKA*.] *Yāre* or *saredha* 'year;' *zyāo* (*zim*) or *aiwigāma* 'winter;' *hama* 'summer.'

[3] *Naemem · yāre-drājō* and *yāre-drājō* are employed together in Vd. III, 36 and 37; cf. Vd. VI, 1 and 43; V, 14.

[4] *Vaghra* 'spring' is indicated by Tomaschek (p. 20) as employed in the Pamir dialects; *zaremaya* (Roth, *ZddmG.* vol. xxxiv, pp. 702–703) means the same. *Saredha* 'year' = Skr. *çarad* 'autumn' (in N. Pers. *sāl* 'year') seems to have also originally denoted, in the dialect of the Avesta, 'the latter part of autumn' or perhaps even 'winter,' because it appears (Vsp. II, 2) as an epithet to *maidhyāirya*, 'the midwinter-day.'

observations may be drawn from this change of signification and analogous etymological facts in the Old-Indian dialect I have already said before[1].

The Eastern Irānians looked upon the night as preceding the day. They reckoned, therefore, by nights, not by days. So the above-mentioned benediction of the fire, literally translated, runs in the following manner: 'In merry mind spend thy life, the nights which thou hast to live[2]!' This fact is of particular interest, since we find it also among the Indians, Germans, and Gauls[3]. From this similarity we might perhaps suppose that the custom of counting by nights existed in the very first ages of the Indo-Germanic race

The month was employed to compute longer spaces of time, as, for instance, the pregnancy of women[4]. If the weather is bad, it is known that the body of dead people must not be brought to the *dakhma*. It must be kept for a time in a pit, *kata*, and is to remain here *two or three nights or a whole month together*, until the bad weather is gone[5].

If there is a dead body in any house, the fire must be directly removed from the hearth, that it may not be exposed to impurity. *Nine nights in winter and a month in summer* must pass by before it is permitted to bring it again into the house[6].

The Calendar of the Avesta has been often, in our time, the subject of accurate investigation[7]. Nevertheless I

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[1] *Zim*, *zyāo* 'winter, year' (cf. also the foregoing note); see *OKA*. p 144 seq.

[2] *Tāo · khshapanō*, Ys. LXII, 10; *vide supra*, p. 76. *Khshapan* 'night,' *ayare* 'day,' *ushağh* 'dawn, morning.'

[3] Zimmer, *AiL*. p. 360.

[4] Vd. V, 45: *aevō-māhīm*, *bimāhīm*, &c.

[5] *Bikhshaparem · vā · thrikhshaparem · vā · māzdrājahīm · vā*, Vd. V, 12; cf. also Vd. V, 54, 55, 56, &c.

[6] *Nava-khshaparem · upa-mānayen · aetę · yōi · Mazdayasna · aiwigāmē · āat · hama · māzdrājahīm*, Vd. V, 42.

[7] Spiegel, *E.A.* vol. iii, p. 665 seq.; and again *ZddmG*. vol. xxxv, p. 642 seq.; Roth, *ZddmG*. vol. xxxiv, p. 698 seq.; C. de Harlez,

hope to bring forward at least some new points and so to be allowed to enlarge in this place on its elucidation.

The year was divided into 12 months of 30 days each, every month into two equal halves of fifteen days. The whole month is a period which elapses between two full or new moons (strictly 29½ days); half a month is the time between full-moon and new-moon. That the bipartition of the month must have been a very old custom will be proved below. Yet I think it very problematical to say that the people of the Avesta observed the week of seven days or that it was of any account in the business of civil life[1]. At any rate it was of course necessary to use a week of seven and of eight days alternately, since the month had 30 days.

The names of the months are, it is true, nowhere completely enumerated in the Avesta. But those that are mentioned in our texts[2] agree fully with the list of the calendar met with in the later Scriptures of the Parsees. So we are entitled to suppose that they were known as far back as the Avesta, and to insert them here without hesitation

| | | |
|---|---|---|
| 1st Month | *Fravashinãm* . . | Farvardīn. |
| 2nd " | *Ashahē-vahishtahē* | Ardabihisht. |
| 3rd " | *Haurvatātō* . . . | Khordād. |
| 4th " | *Tishtryehē* . . . | Tīr. |
| 5th " | *Ameretātō* . . . | Amurdād. |
| 6th " | *Khshathrahē-vairyehē* | Shahrēvar. |
| 7th " | *Mithrahē* . . . | Mihir. |
| 8th " | *Apãm* . . . . . | Ābān. |
| 9th " | *Āthrō* . . . . . | Ādar. |

*Bulletin de l'Athénée Oriental*, 1881, p. 79 seq, p. 159 seq. I regret that I have not been able to read the Essay of Bezzenberger; I know it only from quotations.

[1] This hypothesis is based only upon the use of the expression *vīshaptatha*, which is interpreted by Roth (l. c. 710, note 1) as 'between-seven' and translated by 'week.'

[2] These are the months *Asha-vahishta*, *Tishtrya*, *Khshathra-varya*, *Mithra*, *Dathuō* i.e. 'of the Creator' (*Trad.* 'of the Law'), and *Spentā Ārmaiti*. Westergaard, 'Zend Texts,' p. 318 seq. Spiegel, '*Av. üb.* vol. iii, p. 239 seq.

10th Month: *Dathushō* . . . . Dīn (better 'Creator')
11th „ *Vag̱heush Manag̱hō* Bahman.
12th „ *Speñtayāo Ārmatōish* Spendārmad.

The order of the names is, as justly remarked by Roth, very striking. We should naturally think that Ahura Mazdâ, the Creator, would stand foremost, that after Him the other Amesha Spenta would follow in the usual order, and finally Mithra, Tishtrya, Āpō, Ātar, Fravashi. I must, however, confess that I have not found any satisfactory solution of the problem, and must, therefore, leave it to some more fortunate student.

Roth starts with the theory, that the tenth month must have formed originally the beginning of the year; thus the names of the other Amesha Spenta are, says he, in their due order, save that succeeding couples are separated by the insertion of the Fravashis and Tishtrya. The insertion of the former, he continues, must be accounted for by the fact that a sacred and solemn feast of the *manes* could not be removed from its fixed place in the year, while Tishtrya had a strong foothold in the time of the rising of Sirius.

There can be no doubt that much is explained by this hypothesis, yet many a difficulty still remains. As yet we know not why Spentā Ārmati follows immediately after Vohu-manō and Khshathra-varya stands last of all the Amesha Spenta, and certainly there must also be reasons for this fact. Finally, we should think it more natural that the feast of the manes, Hamaspatmaidhaya, fell in the month of the Fravashis, as the calculation of the calendar demands, rather than in the intercalary days inserted before it.

The day-names are also nowhere distinctly enumerated in the Avesta, yet there is in the Yasna a list of genii completely agreeing with the day-list found in the traditional Scriptures of the Parsees[1]. This is no accident. The author of that passage evidently named the genii on

[1] Ys. XVI, 3 seq.; cf. Sir. I and II; Spiegel, *E.A.* vol. iii, p. 667. Several names, viz. those of the 11th, 15th, 16th, 20th, 26th and 30th days, are also mentioned in the passage of the Avesta cited above (p. 144, note 2).

purpose after the order in which they rank in the calendar. The list runs as follows:

| | | | |
|---|---|---|---|
| 1. | *Ahurahē Mazdāo* | Ormazd | The seven Amshaspands |
| 2. | *Vaghēu*sh *Managhō* | Bahman | |
| 3. | *Ashahę vahi*sh*tahē* | Ardabihisht | |
| 4. | *Khshathrahē vairyehē* | Shahrēvar | |
| 5. | *Spentayāo Ārmatōi*sh | Spendārmad | |
| 6. | *Haurvatātō* | Khordād | |
| 7. | *Ameretātō* | Amerdād | |
| 8. | *Dathushō* | Dīn[1], (probably) | Creator. |
| 9. | *Āthrō* | Ādar | Fire. |
| 10. | *Apãm* | Ābān | Waters. |
| 11. | *Hvare-khshaetahē* | Khorshēd | Sun. |
| 12. | *Māoghō* | Māh | Moon. |
| 13. | *Ti*sh*tryęhē* | Tīr | Sirius. |
| 14. | *Gēu*sh | Gōsh | the Beasts. |
| 15. | *Dathushō* | Dīn[1], (probably) | Creator. |
| 16. | *Mithrahē* | Mihir | Mithra. |
| 17. | *Sraoshahē* | Srōsh | Srausha. |
| 18. | *Rashnao*sh | Rashnu | Rashnu. |
| 19. | *Fravashinãm* | Farvardīn | the *Manes.* |
| 20. | *Verethraghnahē* | Behrām | Vethraghna. |
| 21. | *Rāmanō* | Rām | Rāman. |
| 22. | *Vātahē* | Vāt | Wind. |
| 23. | *Dathushō* | Dīn[1], (probably) | Creator. |
| 24. | *Daenayāo* | Dīn | the Law. |
| 25. | *Ashōi*sh | Ard | Ashi. |
| 26. | *Ar*sh*tātō* | Ashtād | Arshtāt. |
| 27. | *Asmanō* | Asmān | Heaven. |
| 28. | *Zemō* | Zamyād | Earth. |
| 29. | *Māthrahę Spentahę* | Māhrspand | the Holy Word. |
| 30. | *Anaghranãm-raochaghãm* | Anīrān | the 'Lights Without Beginning,' i. e. the Stars. |

[1] [Rather *Dai-pa-Ādar, Dai-pa-Mihir, Dai-pa-Dīn,* Dai=Pers. دی, 'yesterday.' The eighth, fifteenth, and twenty-third days of the month are dedicated to Ahura Mazda, like the first day. They are, therefore, named from the day that follows. *Tr. note.*]

There must still be added the five intercalary days that are every year inserted in order to bring the solar and lunar years into harmony. They are dedicated to the five Gāthās or collections of holy hymns. The first and the last of them are mentioned in a recently quoted passage of the Avesta

1. *Gāthayāo ahunavaithyāo*,
2. *Gāthayāo ushtavaithyāo*,
3. *Gāthayāo speñtāmainvāo*,
4. *Gāthayāo vohu-khshathrayāo*,
5. *Gāthayāo vahishtōishtōish*.

The list of names of days is in perfect order, yet it must occasion surprise that the day Dathush occurs three times. This might perhaps be explained by the fact, that the month of thirty fixed days of the solar year was preceded by a lunar month of varying length.

If we divide the month into its natural halves of fifteen days each, we see that the first half begins with the day of Ahura Mazda, and terminates with that of the Creator; besides that in the very middle of each half-month an additional day, Dathushō, is inserted and proves superfluous by its very position. In my opinion there existed at first settled names only for twice fourteen days. As the synodical month had only twenty-nine days and a half, it was necessary that months of twenty-nine and thirty days should alternate. If needed, an intercalary day could be inserted in the middle of the first or the second half of the month, or in each of them, to keep pace with the lunar phases in the computation of time. Nor can it appear at all strange that these intercalated days were dedicated to the Creator.

During the transition from the lunar to the solar calendar, it was natural that the month of thirty days soon became the standard of calculation. The intercalary days had their settled fixed places as well as the other days. Now it led to no practical disadvantage that the month was not always conformable to the changes of the moon, for it had lost its original value and served only as a convenient subdivision of the year, which is too long for the wants of civil life.

The Irānian year had also its regularly recurring feasts [1]. In the first place, as stated by the Parsees, those days in every month were held sacred which had the same names as the months in which they fell. In the first month the nineteenth day (since it is dedicated to the *manes*); in the second month the third day; in the third month the sixteenth day; in the fourth month the thirteenth day; in the fifth month the seventh day; in the sixth month the fourth day; in the seventh month the sixteenth day; in the eighth month the tenth day; in the ninth month the ninth day; in the tenth month the first day, perhaps also the eighth, fifteenth and twenty-third; in the eleventh month the second day; in the twelfth month the fifth day.

To these days are to be added the six principal feasts, the so-called GĀHANBĀRS, which are annexed, as Roth justly remarks, to the different seasons, and their importance for civil life. But I cannot believe that their names were originally the names of the seasons. I should prefer to think that they became such in later times. The names of the annual feasts are:

1. MAIDHYŌ-ZAREMAYA, in the month of Asha-vahishta on the day of Dathushō before Mithra (the fifteenth day of the second month).
2. MAIDHYŌSHEMA, in the month of Tishtrya on the day of Dathushō before Mithra (the fifteenth day of the fourth month).
3. PAITSH-HAHYA, in the month of Khshathra-varya on the day of Anaghranãm (the thirtieth day of the sixth month).
4. AYĀTHREMA, in the month of Mithra on the day of Anaghranãm (the thirtieth day of the seventh month).
5. MAIDHYĀIRYA, in the month of Dathushō on the day of Verthraghna (the twentieth day of the tenth month).
6. HAMASPATMAEDHAYA, on the day of Vahishtōishti, and thus on the last of the five intercalary days [2].

[1] *Yāriya-ratavō*, literally 'yearly times.'

[2] Ys. I, 9; II, 9; Visp. I, 2; Āfr. Gāhanbār, 7 seq. The opinion

Each of these feasts comprises five days, so that the principal *dies solemnis* falls on the last of them. The feast Hamaspatmaidhaya extends, therefore, over all the intercalary days; the feast Madhyō-zarmaya lasted in the second month from the eleventh to the fifteenth day; the feast Madhyōshma, in the fourth month, likewise from the eleventh to the fifteenth day; the feast Maidhyārya, in the tenth month, from the sixteenth to the twentieth day. And so, too, the other feasts.

It is possible that the prolonged duration of these holidays, as well as their later relation to the six periods of creation, is nothing but an addition of more modern times. The first feast is designed to celebrate the creation of the heavens, the second that of water, the third of the earth, the fourth the creation of plants, the fifth that of animals, and the sixth the creation of man. It cannot be denied that this connection of the annual feasts with the history of creation cannot be regarded as an invention of the priests thus to render the Gāhanbārs more venerable. Originally they were certainly nothing but rural feasts, and, therefore, originated in rural life.

This is proved both by the meanings of the names given to the several feasts, and by the epithets which they receive in the Avesta.

Madhyō-zarmaya denotes 'midspring,' Madhyōshma 'midsummer,' Madhyārya 'midwinter' or, more accurately, 'midyear.' The first is called the time of blossoming, the second the time of the hay crop, the third the autumn or winter time[1]. Patish-hahya is generally understood as the

of Roth, that we have old names of the seasons in the *Gāhanbārs*, is contradicted, I think, by his own etymologies. If *maidhyō-shema* means 'midsummer,' *maidhyō-zaremaya* 'midspring' and *maidhyāirya* 'midwinter,' then these names can only denote originally certain single days. That it may be implied from the epithet *saredha* added to *maidhyāirya*, that in later times these names came to signify seasons, is quite erroneously explained by Roth. It means 'year,' perhaps originally 'autumn,' 'late autumn,' about the last period before midwinter-day.

[1] Vsp. I, 2, *maidhyō-zaremaya payagha*, *maidhyōshema vāstrō-*

time of the corn crop, harvest time, and so is fitly called 'corn-bearing[1].' Ayāthrema is, according to Roth's ingenious exposition, the time in which the cattle return from the mountain-pastures into the valleys, and the rams are allowed to go to the ewes[2]. The explanation of the name Hamaspatmaidhaya offers the greatest difficulty. In the opinion of Roth this is the time in which the farmer makes his preparations for the sowing. I would rather adopt the opinion of C. de Harlez in referring this name to the great feast of the *manes* and the solemn preparations for it[3].

The Gāhanbārs have in Afrīn-e-Gāhanbār each its peculiar number. The first number signifies the anniversary on which the first feast falls, each additional number the interval between the feast in question and the one previous. All these numbers must, therefore, make up:

| | |
|---|---|
| 1. Madhyō-zarmaya | 45 |
| 2. Madhyōshma | 60 |
| 3. Patish-hahya | 75 |
| 4. Ayāthrema | 30 |
| 5. Madhyārya | 80 |
| 6. Hamaspatmaidhaya | 75 |
| Total | 365 |

Assuming that Madhyōshma must fall on midsummer-

*dātainya, maidhyāirya saredha* (*vide* p. 146 of *OKA.*). Spiegel and Hübschmann have recently pointed out (*ZddmG.* vol. xxxv, pp. 643 and 665–666) that *maidhyōshema* can have no connection with *hama*, and that the *maidhyō-shad* quoted by Roth as analogous to it is merely a misreading for *maidhyōi-shad.*

[1] *Paitish-hahya* (cf. also the correct explanation in Spiegel, *Av. ub.* vol. ii, pp. 7–8, de Harlez, *Av. tr.* vol. ii, p. 34, and Bezzenberger in *ZddmG.* vol. xxxv, p. 643) from *hahya*=Skr. *sasya*+ *paiti* (as *paiti-puthra, paitish-ayaṅh*).

[2] *Ayāthrema* · *fraourvaęshtra* · *varshni-harshta*; the former from *āyāthra*=Skr. *ājātra* from root *yā*+*ā*; *fraourvaeshtra* from root *urvis* (certainly not identical with *vṛt*!)+*fra*; *varshni-harshta* from *varshni*=Skr. *vrshan*+*harez* 'to let loose'=Skr. *srj.*

[3] *Hamaspatmaęđhaya* · *aretō-kerethna*; the former is not easily to be explained, the latter is certainly from *areta*=*asha*+*kerethna* from root *kar.*

day, the twenty-first of June, Roth has made out that the old Irānian year began on the ninth of March, since the one hundred and fifth day of the year was fixed for this feast. If this calculation cannot be said to be absolutely certain, since the assumption on which it is based can be considered only hypothetical, it appears at any rate most probable Besides, it is quite in unison with the statements of the Parsees, who say that the first month corresponds to March, the second to April, &c.

Hence result the following dates for each month,

| | | |
|---|---|---|
| 1 | Farvardin . . | 9th March — 7th April. |
| 2 | Ardabihisht . | 8th April — 7th May. |
| 3. | Khordād . | 8th May — 6th June. |
| 4. | Tīr . . . . | 7th June — 6th July. |
| 5. | Amerdād . . | 7th July — 5th August. |
| 6. | Shahrēvar . . | 6th August — 4th September |
| 7. | Mihir . . . | 5th September — 4th October. |
| 8. | Ābān . . | 5th October — 3rd November. |
| 9. | Ādar . . . | 4th November — 3rd December. |
| 10. | Dīn . . . . | 4th December — 2nd January. |
| 11. | Bahman . . | 3rd January — 1st February. |
| 12. | Spendārmad . | 2nd February — 3rd March. |

The five intercalary days, 4th–8th March.

The annual feasts are celebrated as follows:

| | | |
|---|---|---|
| 1. | Madhyō-zarmaya . | on the (18th —) 22nd April. |
| 2. | Madhyōshma. . . | „ (17th —) 21st June. |
| 3. | Patish-haya . . . | „ (31st Aug.—) 4th September. |
| 4. | Ayāthrema . . . | „ (30th Sept.—) 4th October. |
| 5. | Madhyārya . . . | „ (19th —) 23rd December. |
| 6. | Hamaspatmaidhaya | „ (4th —) 8th March. |

We have thus fixed the year as it originally stood in the Avesta Calendar. It is a moveable year; and, consisting only of 365 days, it must every fourth year fall one day in arrears when compared with the solar year. It is no part of my task to solve the question how this inconvenience was obviated, since I am only obliged to prove the original institution of the fixed year[1].

[1] Cf. Von Gutschmid *Über das Iranische Jahr* in the 'Transac-

The calendar of the Avesta has resulted, as one may observe at a glance, from a combination of solar and lunar chronology. I shall now attempt to describe the manner of this combination

The month of thirty days, employed in the solar year, was evidently preceded by a quite primitive mode of calculation from one new-moon or full-moon to another, or more probably from new-moon to full-moon, and again from full-moon to new. This is indicated, as I have said already[1], by the arrangement of the days, particularly by the repeated use of the day Dathushō, which became necessary on account of the variability of the synodical month.

Additional proof of the originally lunar character of the Avesta calendar is afforded by the numbers which indicate the intervals between the several Gāhanbārs.

Spiegel has observed that all these numbers are divisible by five[2]. Hence he concludes that the Gāhanbārs belong to a calendar in which every week consists of five days. However I cannot agree with this conclusion, since a week of five days is rather uncommon.

I am convinced that the Gāhanbār numbers are based on the synodical half-month of fifteen days; this half-month must be regarded as the basis of the whole chronology in general. This I infer from the fact that all those numbers are multiples of fifteen.

The number of the Madhyārya-feast seems to form an exception. But even here the seeming difficulty is overcome in the simplest manner, by resolving 80 into 75 + 5, i.e. into five half-months and five intercalary days.

The Gāhanbār numbers further show clearly that the year was divided into two half-years:

1. 45 + 60 + 75 = 180
2. 30 + 75 (+ 5) + 75 = 180 (185).

Probably the half-year was more employed in civil life than the complete year. Being a shorter period it was

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tions of the Scientific Society of Saxony,' 1862, 1 seq.; Spiegel, *E.A.* vol. iii, pp. 669–670.

[1] *Vide supra* p. 147. [2] *ZddmG.* vol. xxxv, p. 645, note 2.

more convenient for calculations and agreed moreover with the generally known and popular division of the year into summer and winter This may be seen from the very distribution of the Gāhanbārs over these half-years:

| | |
|---|---|
| 1 Madhyō-zarmaya, | 2. Ayāthrema, |
| *Madhyōshma,* | *Madhyārya,* |
| Patish-haya, | Hamaspatmaidhaya. |

It is evident that each of the two solstices forms the centre and turning point of a half year, so that, indeed, the first more or less corresponds with the warm, the second with the cold season.

But we can trace the calendar to a still more primitive form. Since the name Madhyārya means literally not 'midwinter,' but 'midyear,' the year must necessarily have once begun with the summer solstice, or still more correctly with the day next following. Only in this case the *Bruma* (or the winter solstice) forms also the middle of the year.

But since the Madhyārya itself is associated with the number 80, we might justly conclude that along with the combination of the lunar and solar calendars the five intercalary days of the winter solstice have been inserted.

The oldest calendar may be, therefore, thus arranged:

| | |
|---|---|
| 1st Month: | 22nd June — 21st July, |
| 2nd „ | 22nd July — 20th August, |
| 3rd „ | 21st August — 19th September, |
| 4th „ | 20th September — 19th October, |
| 5th „ | 20th October — 18th November, |
| 6th „ | 19th November — 18th December. |
| Intercalary days 19th — 23rd December. | |
| 7th Month: | 24th December — 22nd January, |
| 8th „ | 23rd January — 21st February, |
| 9th „ | 22nd February — 23rd March, |
| 10th „ | 24th March — 22nd April, |
| 11th „ | 23rd April — 22nd May, |
| 12th „ | 23rd May — 21st June. |

Here the winter solstice forms, indeed, the centre of the whole year; for the 21st of December falls exactly on the middle of the intercalary days.

The intercalary days and the additional days of the synodical month may both have been dedicated to Ahura Mazda, the 'Creator', and now we have, I think, arrived at the point, proceeding from which we can explain why the month falling about the winter solstice was called DATHUSHŌ.

The whole calendar was, therefore, calculated from the winter solstice, the original centre of the year; it was afterwards put back by 105 days, and, indeed, in such a manner that the intercalary days also were no longer inserted at the time of the winter solstice but before the beginning of the new year. The reason lay evidently in the fact that the official, I should like to say the ecclesiastical, calendar was to be brought in harmony with the popular division of the year into a winter and a summer half-year. This could only be done by putting the winter and summer solstices, which had always before formed the division between the two half-years, almost in the middle of them.

What may have really occasioned this alteration of the calendar, I cannot say; however I am satisfied with having made an attempt at reducing the calendar of the Avesta to its primitive form as far as possible.

Finally, the divisions of the day are still to be treated of.

The Avesta recognizes five parts of the day [1]. They are called in due order: 1) HĀVANI, 2) RAPITHWINA, 3) UZAYERINA, 4) AWISRUTHREMA, 5) USHAHINA [2]. The second is, here at least, without doubt midday, for its name serves, just as in our languages, to denote the southern sky [3]. About, or till the time Rapithwina, Tishtrya and Apausha fight against each other [4]. This, it is true, is very strange, since Tishtrya is an astral *yazata*. But the recollection of this fact had apparently disappeared, before the idea was formed.

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[1] *Asnya ratavō* or *ayara ratavō*.

[2] *Hāvani*, *Rapithwina*, *Uzayeirina*, *Aiwisruthrema* with the constant epithet *aibigaya*, and *Ushahina*. *Vide* Ys. I, 3 seq., II, 3 seq. (here are also the names of the genii to whom the single parts of the day are consecrated), Gāh. I–V.

[3] *Vide supra* p. 133. The name seems to be connected with *pitu* 'food.'

[4] Yt. VIII, 25.

And if the feud between Tishtrya and Apausha symbolizes only the opposition between the cool weather after summer and the heat of summer, the time of midday seems to be very appropriately selected.

At the same time takes place the combat between Kersāspa and the dragon:

> On him (the dragon) did Kersāspa cook in the iron kettle his meat *about the time of midday*, and the dragon grew hot and began to sweat; and he burst forth from beneath the kettle and poured out the boiling water, and affrighted started back the manly-hearted Kersāspa [1].

Moreover, there cannot be any doubt that *Ushahina* must be *the time about dawn* [2]. In the same way we learn from the signification of the name itself that *Uzayerina* is that hour of the day in which the stars rise, i. e. *the evening* [3].

*Hāvani* comes between Ushahina and Rapithwina and is, consequently, *the forenoon*. This period is so named probably from the circumstance [4] that in it the sacrificial ceremonies are performed and in particular the sacred *hauma* beverage is prepared. For this reason the Yazata Hauma visits Zaratushtra at the time Hāvani, just as he is going to purify the fireplace. Finally, the time *Aiwisruthrema* falls between Uzayerina and Ushahina, and is, therefore, *the midnight*, the time for being watchful and wakeful [5].

Now we shall see that the genii to whom the single parts of the day are consecrated, are by no means arbitrarily chosen, but stand in real, and for the most part clear, relation to the several periods which they preside over.

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[1] Yt. IX, 11; Yt. XIX, 40.

[2] From *ushaṅh* = Skr. *ushas* 'dawn.'

[3] *Uzayeirina* is derived from *uzayara*; it is used (Vd. XXI, 5, 9, 13) for the rising of the sun, moon and stars (from root *ir* + *uz*).

[4] *Hāvani* from rt. *hu* = Skr. *su*.

[5] *Aiwisruthrema* evidently comes from *aiwisruthra*, 'watch, guard' (from root *sru* + *aiwi* = Skr. *abhi-çru*); comp. *ayāthrema* from *āyāthra*.

*Ushahina* belongs to Srausha. He is reputed the genius of wakefulness, and it is his duty at early morning to awaken mankind from slumber and to chase away the demon of sleep: He is aided in his task by his herald, Chanticleer (the domestic cock).

*Hāvani*, or the forenoon, is under the care of Mithra, because he is the yazata of the rising and heaven-ascending sun. Sunrise seems to have been considered, at least in later times, the beginning of the day, and not midday; for *Hāvani* opens the dance or circular course of day. At an earlier period the night was thought to precede the day, and hence people were accustomed to reckon time by nights.

*Aiwisruthrema* is ruled by the *manes*, who guard human kind at this time, and the genii, e.g. Valour, Victory, and Superiority, by whose aid nightly dangers are warded off. Noon, finally, is consecrated to the genius of fire, and evening to that of water.

## § 16. *Religion and Superstition.*

We cannot omit in this place one of the highest spiritual gifts of mankind—Religion. The position in which a people place themselves with regard to their Deity is without doubt an important phenomenon in their intellectual life and is characteristic of their manner of viewing things.

And yet I must restrict my remarks to what is indispensable. The religion of the Avesta and the ideas connected with the different genii have already been described by several authors. A new and exhaustive description would afford sufficient matter for a special investigation and would at present lead us too far from our task. I must, therefore, content myself with touching upon some peculiarities of the Avesta religion, illustrative of its spirit and intrinsic excellence.

In comparing the religion of the Avesta with that of the closely related Vedic Indians, a radical difference will force itself upon our observation[1].

[1] [Compare the following remarks of Mr. William D. Whitney (Professor of Sanskrit and Comparative Philology in Yale College)

In the Rig-veda it would be difficult to say who appears as the principal deity; Varuna and Indra are known to be represented as fighting for the ascendancy. And, besides, to every poet that god appears the most great, powerful

in his Chapter on 'The Avesta.' *Vide* 'Oriental and Linguistic Studies,' p. 191.

'The Zoroastrian religion is one of the most prominent among the forms of belief which have prevailed upon the earth, by reason both of the influence which it has exerted and of its own intrinsic character . . . The later Jewish faith is believed by many to exhibit evident traces of Zoroastrian doctrines, borrowed during the captivity in Babylonia, and the creeds of some Oriental Christian sects, as well as of a portion of the adherents of Islam, have derived essential features from the same source. But the influence which its position only gave it the opportunity of exercising, was assured to it by its own exalted character. Of all the religions of Indo-European origin, of all the religions of the ancient gentile world, it may fairly be claimed to have been the most noble and worthy of admiration, for the depth of its philosophy, the spirituality of its views and doctrines, and the purity of its morality. Valuable notices respecting it had been given by the classical writers, yet they had been altogether insufficient to convey a clear view even of its then condition in the western provinces to which it had spread, much less to illustrate its origin, and the history of its development in the land of its birth Had the Avesta no other merit than that of laying before us a full picture of the ancient Persian religion, it would be a document of incalculable value to the student of antiquity.'

Also compare Rev. Dr. Mitchell on the merits of Zoroastrianism, in his short tract on 'The Zend-Avesta,' pp. 49-50:

'There are several characteristics which entitle the Zoroastrian faith to a high place among Gentile systems of religion. (1) It ascribes no immoral attributes to the object of worship. Ahura Mazda, the supreme divinity, stands ethically much higher than the popular gods of Pagan nations generally. The Avesta, as we have seen, retains much of nature-worship; but evil qualities are never ascribed either to the physical object or the being who presides over it. (2) The Avesta sanctions no immoral acts as a part of worship. (3) None of the prescribed forms of worship is marked by cruelty. (4) In the great contest between light and darkness, the Avesta exhorts the true worshipper not to remain

and venerable, to whom his songs are addressed. To him he ascribes all the qualities and powers which make up, in his opinion, the nature of the Deity. In the Avesta, on the contrary, rank and order are minutely and exactly established.

As the chief of the whole world, visible and invisible, ranks Ahura Mazda. He is the Creator and Lord of the Universe, no one equals him in honour and power. Next to Him rank, as the highest of the genii, the six Amesha Spenta: Vohu-manō, Asha-vahishta, Khshathra-varya, Spentā-Ārmati, Harvatāt, and Amertāt. To each of them a peculiar sphere of activity and dominion in this visible world is allotted. To Vohu manō is confided the protection of beasts, perhaps originally of mankind too, to Asha the care of fire, to Khshathra of metals, to Ārmati of the earth, and to the two last of water and of plants. The Amesha Spenta are followed by the *yazatas*, the great host of inferior genii, among whom Mithra, Anāhita, and others are prominent.

With the same systematic accuracy and uniformity is the empire of the evil spirits organized. The first of the demons, the counterpart of Ahura in everything, is Angra Manyu, who is all death. Round him are grouped, next in

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passive, but to contend with all his might against the productions of the Evil Principle. (5) One remarkable characteristic of the system is the absence of image-worship. (6) The Avesta never despairs of the future of humanity; it affirms the final victory of good over evil.

'In regard to all these points there is a striking difference between Zoroastrianism and Hinduism. It is not easy to explain how the former system struggled successfully against that fatal gravitation downwards, which made primitive Hinduism sink deeper and deeper in the mire; but the fact, at all events, is undeniable.

'Assuredly, we have no wish to undervalue the importance of the great characteristics of Zoroastrianism that have now been mentioned; and we might point to yet other merits, such as (7) its encouragement of agriculture, (8) its inculcation of truth in thought, word, and deed, (9) the position of respect it assigns to women, and (10) the kindness towards, at least, Zoroastrians which it inculcates.' *Tr.*]

order, the six Arch-daivas, who, sometimes in their very names, are opposed to the Amesha Spenta. The widest circle is formed by the great army of minor demons and infernal fiends.

Thus the whole spiritual world is divided into two great equally organized parties, the party of light and good, and that of darkness and evil. Nevertheless, we cannot speak of a proper dualism, since, though both spirits, the good and the evil, co-exist from the beginning [1], yet, according to the doctrine of the Avesta, the latter will succumb in the decisive battle at the end of the world [2].

Like the invisible world, the visible is also divided between two diametrically opposite parties. Every man is either good or bad, every animal a creature either of light or of darkness; even more, in nearly every object there is a combination of both powers. Such a separation was suggested in Irān by external circumstances, the extraordinarily great differences of the climate, the sudden transitions from cold to heat, the immediate proximity of fertile fields and deserts, and even the historical and social separation into nomad hordes and sedentary farmers. Yet the consistent manner in which this separation is everywhere followed out in the Avesta must be the work of a conscious speculation.

Whatever the religion of the Avesta has lost in poetical strength and life on the one side, it has gained, without doubt, on the other, in moral profundity. It approaches monotheism by far more nearly than the Vedic religion; as it knows one Eternal Lord and God, of whom the other genii are servants and helpmates.

Personifications of natural powers are by no means the

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[1] Ys. XXX, 4:

'When both spirits came together from the beginning to create
Life and death, and as the world should be at its end
The evil one chose the impious, but to the pious there came
the Best Mind.'

In Ys. XXX, 3 Ahura and Angra Manyu are mentioned as twins, *yēma*.

[2] *Vide supra* pp. 110–111; Yt. XIX, *ad finem*.

ideal of the orthodox Zoroastrian; and though Mithra and Anāhita may have had partisans and worshippers enough among the common people, in the system itself they give place to deities that prove to be mere hypostases or personifications of ethical conceptions. Vohu-manō is, literally translated, *the good mind*, Asha-vahishta, *the best piety*, Ārmati, *the devoted and devout resignation*; and these names are, in hundreds of passages in the Avesta, employed in their purely abstract signification. These notions cannot be said to have been exalted into real personages.

Since every individual must necessarily decide either for the party of Ahura or that of Angra Manyu, indifferentism is impossible, and every one must exactly know and fulfil the duties which are imposed upon him by the Deity. The less the forms of the divine beings of the Avesta may have satisfied the imagination, the more impression must have been made by its peculiarly moral energy on every heart and mind.

We must confess that a people contented with such a religion lacks fancy and poetical elevation, but it has a highly respectable moral soberness. A nation of this description will produce no great poet, but will attain a high degree of ethical perception.

Before I discuss the Ethics of the Avesta I insert here, by way of an appendix, some words concerning witchcraft, enchantment and similar superstitions which, though existing among the old Irānian people, do not seem to have had any great importance or diffusion. If the whole world be supposed to be full of evil spirits and demons, as in the Avesta, you may easily perceive that people thought themselves menaced and endangered by these dismal powers, and endeavoured to frustrate their baneful efforts. To heretics and misbelievers was ascribed some influence on the vegetation of the earth[1]; they were commonly thought to possess evidently supernatural or magical powers. In this way only will it be intelligible that *Yātu* denotes a

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[1] Vd. IX, 53-57; XVIII, 63.

heretic or an apostate as well as a sorcerer; *Pairika* is a foreign, unbelieving woman, but at the same time also a sorceress with superhuman demoniacal faculties[1].

Not man alone, but beasts also were assaulted by these demons, the enchantment of cattle especially was generally believed in. If a bull started or a cow stumbled down a precipice, it was thought to have been caused by demons[2]. Everything bad in this world was believed to come from them. The best protection and shelter against them were prayers Yet we may understand that peculiar words were thought peculiarly efficacious in certain cases, and regarded as a counter-charm able to repel the attacks of evil spirits. People especially believed that maladies could be driven away by health-giving sayings[3], nay, this manner of curing diseases was considered the very best and most appropriate.

But enchanting power was ascribed not only to sayings and prayers, but also to certain objects. The feathers and bones of the bird *Vārajan* or *Vārenjana*, denoting perhaps the owl, were believed to protect against wounds and to lay enemies under a spell so that they could by no means gain victory[4].

> 'Of the thick-feathered bird *Vārenjana* a feather seek to thee, O Zarathushtra! by it fortify thy body and bewitch thy enemies.
>
> 'For if a man wears bones of this fleet bird or feathers of this fleet bird:
>
> 'No powerful ruler can kill him or make him flee; rich honour is brought home, rich glory secured to him and shelter by the feather of the bird.'

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[1] That *yātu* must have meant 'witchcraft' already in the Arian time, is proved by the Old-Indian *yātu* 'wizard,' and the New-Persian *jādu* with the same signification.

[2] Therefore an evil spirit *Snāvidhaki* has the names *Srvō-jan* (probably 'killing horned cattle,' from *sru*, *srva* 'horn') and *aseghō-gao* 'enchanting cattle' (Skr. *āças* and *açás*). Cf. also Ys. XXXII, 12.

[3] Vd. VII, 44; *vachāo*-*baeshazya*, Vd. IX, 27. See below.

[4] Yt. XIV, 35; Geldner, *Metrik*, § 142.

## § 17. *Morality.*

*Piety in thoughts, words and works*, was the chief precept of the Zoroastrian religion[1]. In it everything else is included; it is the sum of all precepts, the doctrine that is always repeated anew, that is, I dare say, met with on every page of the Avesta. He who thinks, speaks and acts well, or, as it is said, according to religion[2], is a perfect worshipper of Mazda (*Mazdayasna*) and a worthy follower of Zarathushtra. This triple injunction is a summary of the whole ethical life of the Zoroastrian.

It would be superfluous to attempt proving this from any passage of the later Avesta; I will put forward here only one strophe from the Gāthās to prove that this doctrine existed already in the oldest period of the Mazdayasnian community:

'The two spirits, that first existed,
The twins, announced to me in a dream,
*What good was and what evil*
*In thoughts, and words, and works.*
Of this the pious choose
The right, but not the bad ones[3].'

It affords, indeed, proof of a great ethical tendency and of a very sober and profound way of thinking, that the Avesta people, or at least the priests of their religion, arrived at the truth that sins by thought must be ranked with sins

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[1] *Humata, hūkhta, huvarshta* 'good thoughts, words and works'; united they form *asha*=Skr. *ṛta* 'piety.' According to Darmesteter (*Ormuzd et Ahriman*, p. 8 seq.) these three notions had originally a liturgical signification, viz.=Skr. *sumati* 'devotion,' *sūkta* 'saying, prayer,' *sukṛta* 'sacrifice.' But I have no doubt that they developed already in the Avesta into really ethical notions.

[2] *Anumatēē · daenayāo, anūkhtēē · daēnayāo, anuvarshtēē daēnayāo*, Yt. V, 18. Cf. *Vsp.* II, 5.

[3] Ys. XXX, 3; similarly Ys. XLV, 8.

by deed, and that, therefore, the actual root and source of everything good or bad must be sought for in the mind. It would not be easy to find a people that attained, under equal or similar historical conditions, to such a height of ethical knowledge In some Varuna-hymns there occasionally appear similar ideas of the guilt of sin, and the reconciliation of Conscience with the Deity; but they are only isolated flashes, whereas we have, in the Avesta, a settled and established doctrine that is, or should be, common to every one.

Externality and work-righteousness are by no means wanting in the religion of the Avesta. Offences can be expiated by punctiliously prescribed rites of expiation, and here it seems, indeed, that more stress was laid on the external performance of the expiatory ordinance than on the internal renewal and purification of the mind[1]. Even a kind of indulgence is not unheard of. To certain meritorious works is attributed the effect of removing all guilt and sin from him who performs them. Or it was possible to wipe out, by peculiarly severe atonements, not only the special sin on account of which the atonement was performed, but also other offences committed in former times or unconsciously[2]. Nor should we claim too much, nor

[1] [Comp Mr. Cook's remarks on the opening chapter of the Gāthās in 'The Origin of Religion and Language,' p. 216: 'It is especially to be remarked that there is not in it (Ys. XXVIII), from first to last, a trace of so-called naturalism. No phenomena of nature are personified, invoked or noticed. The universe is conceived as the creation, not as the manifestation, of one Supreme Being, who is, however, not isolated, but surrounded by spiritual principles, which embody, so to speak, or vividly represent His highest attributes, perfect purity as Asha, perfect goodness as Vohumanō. Man approaches this Deity, and is favoured by Him so far as he reflects those attributes. No offering but that of a pure good spirit is suggested; prayer owes all its efficacy to their presence. The seer has one desire—to know the Supreme Being as He is, and knowing Him to communicate to others the blessings of that gift.' *Tr.*]

[2] *Vide* e.g. Vd. V, 26, with which you may compare Vd. III,

expect in the ancient world ideas not formed before the time of our modern and Christian culture.

As cardinal virtues of the old Irānian must be considered *truthfulness* and *fidelity*, *charity* and *benevolence*.

*The love of truth* is praised as a prominent characteristic of the Western Irānian by the Western writers. Herodotus expressly states that the Persians think nothing so shameful as a lie; after which, says he, ranks the contracting of debts, for this reason particularly, that such as contract debts are now and then compelled to take refuge in falsehood[1]. Covenants are sacred and inviolable to the Avesta, those which are pledged by a mere word not less than those which are pledged with hand or pawn[2]. The covenant is called *mithra*, doubtless after the *yazata* Mithra, the all-seeing genius of the sun, who, penetrating the whole world with his clear light, sees all things, even the most hidden, and so becomes the guardian and protector of truth, fidelity and covenants. He who betrays a covenant betrays the *yazata* himself, and becomes a betrayer of Mithra or a breaker of covenants[3]. This expression is used almost in the same meaning as *daeva* or *drvañtō*, 'the demons,' 'the evil ones.' The strict observance of a plighted word is regarded as characteristic of the Irānian and the adherent

21 and IX, 50. Conformably to Vd. XIII, 7 the killing of a *zarimyagura* seems to have effected a remission of sins.

[1] Herodotus, i, 138; Spiegel, *E A* vol iii, p. 684 seq. Darius too expresses, in an inscription (H. 14 seq.), his detestation of 'lying,' if the word *drauga*, which is here used, means nothing less than 'revolt, uproar,' cf. *Bh.* I, 38. 'The army revolted and the lie (uproar) increased in the provinces.'

[2] Vd. IV, 2; cf. also Yt. X *passim*.

[3] *Mithrō-druj*. A pernicious betrayer of Mithra destroys the whole land (Yt. X, 2), probably because he draws down the vengeance of the *yazata*. Mithra takes away in his rage, strength and courage from the Mithra-deceivers (Yt. X, 23); their dwellings shall be deserted and desolate (Yt. X, 38). The *mithrō-druj* and the *mithrō-zya* are named along with thieves, robbers, &c. (Ys. LXI, 3). *Verthraghna*, likewise, deprives the Mithra-deceivers of their strength (Yt. XIV, 63).

of Zarathushtra, and he who is wanting in fidelity and veracity cuts himself off from the national and religious community.

Lying is a creation of the evil spirits, and in by-gone days it was exceedingly powerful on earth. No sooner than after the birth of Zarathushtra were bounds set to it For he revealed to man the holy religion, the most efficacious weapon against lying and deceit. It is therefore that the demons break forth into the wild complaint: 'Born, alas! is the pious Zarathushtra in the house of Pourushaspa! How can we contrive destruction against him? He is a blow (thunderbolt) to the demons, he is an adversary of the demons, he is the demons' enemy! Down tumble the worshippers of the demons, down the *druj-nasush* produced by the demons, down the falsely-spoken lie[1]!'

*Charity* of course was restricted to followers of the same creed. This cannot seem strange considering the great gulf which Zoroastrians maintained between themselves and the adherents of other doctrines. To succour an unbeliever would be like a strengthening of the dominion of Evil. But charity to poor and distressed brethren is prescribed in the Avesta. Their prayers should be heard; he who grants them not is committing sin. In the Gāthās it is said.

'What is your power, and what your riches,
That I may join you, O Mazda, with my deeds,
In sanctity and pious mind
*To nourish the poor man*, devoted to you?
We have renounced all
The demons and *Khrafstra-men*[2]!'

In the Vendidād the precept of mercy is proclaimed no less explicitly in the following passage: 'He who does not grant the prayer of a begging man will become a thief of

[1] Vd. XIX, 46: *draogha-mithaokhta*.

[2] Ys. XXXIV, 5. In the first verse we should read *hakhmī*, which is strengthened by the manuscript K 5, Bartholomä, *Gāthās*, p. 39; in the last line *parē* must be expungéd.

prayer by depriving him that made it[1].' From these words it becomes evident that the Mazdayasna must regard a request made to him as a deposit. If he does not grant it he keeps back, in a certain measure, the deposit, and commits in this way a theft to the damage of the asker.

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[1] Vd. IV, 1. My opinion agrees with that of Harlez (*Av. tr* I, p. 114); another opinion, but too ingenious, is that of Spiegel, *Comm.* vol. i, p. 116.

# CHAPTER IV.

## ECONOMICAL LIFE.

### § 18. *Cattle-Breeding.*

THE beasts fed and tended by the Avesta people are divided into large groups, herds and flocks[1]. In the first group are numbered cattle, horses, camels and asses; in the second, goats and sheep. The rearing of poultry was, likewise, known to the old Irānians. It is certain that they knew of the cock, perhaps also of pigeons[2].

The dog must also be mentioned as a domestic animal of the Avesta people. He was their faithful companion on their wanderings and a careful guardian of their herds. He was, therefore, highly esteemed and treated with kindness, nay, even with veneration, by the worshippers of Mazda.

#### CATTLE.

The cattle, which are now reared in Central Asia and in the North-Eastern parts of Irān, by no means excel in beauty or other good qualities. In the plains there grows only a short and salty kind of grass[3]. The valleys in the high mountains of the Hindukush are, on account of the exceedingly rugged and barren quality of the soil, less adapted to the breeding of cattle than of sheep and goats. It is true that even the inhabitants of Wakhān and the Eastern

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[1] Beasts, as opposed to men, are generally called *pasu*. At the same time this word when used with *anumaya* means 'flock,' as opposed to *staora* 'herd.'

[2] Tame poultry are meant by *vaya* in the *Yima*-legend, if this word (Vd. II, 8) is equivalent to *pasu*, *staora* and *svan*, that is, to animals which are all domestic. Pigeons may be understood by *vayaeibya · pateretaeibya*, which are offered to Mithra together with *pasu* and *staora* (Yt. X, 119), i. e. with other domestic animals.

[3] Vámbéry, *Skizzen*, 198; Polak, *Persien*, II, 98; Spiegel, *E. A.* vol. i, p. 261; Khanikoff, *Bokhārā*, p. 302: 'The horned cattle of Bokhārā are in a very miserable state.'

parts of the Pāmir possess herds of cattle[1]; but, from an agricultural point of view, they are in every respect of inferior importance to sheep and goats.

With the old Irānian people things were quite different, according to what we learn in the Avesta. Hence we must conclude that in those times the rearing of cattle[2] was by far more popular and general than the breeding of flocks. Sheep and goats are mentioned only occasionally without any further remarks. But the cow plays, in all parts of the Avesta, the most ancient as well as the most modern, a very prominent part and her excellence was generally valued and acknowledged.

There is a double reason for this fact.

Cattle excel, indeed, all other domestic animals in usefulness for a farming population. They afforded to the old Irānian nearly everything he wanted in his frugal life. They must have been used in farming, for drawing carriages[3], and also, in all likelihood, for bearing heavy loads[4]. The milk of the cow was a favourite and universal article of food; butter and cheese were made of it. The flesh seems also to have been dressed for eating[5]. Bows were strung with the sinews of the ox, and the manner of working the hides of slaughtered beasts seems to have been known.

Besides, it must not be forgotten that the Avesta was

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[1] Gordon, 'Pāmir,' pp. 113, 136. Cows and sheep are, according to Wood ('Journey,' p. 249), the domestic animals of the inhabitants of Shignān, Roshān, and Darwāz.

[2] *Gao* 'cattle,' *ukhshan* 'ox, bull,' also *gao-arshan* (Yt. XIV, 7) 'male cattle,' *gāo-daenu* 'female cattle, cow.' *Gaodāyu* or *gaodaya* 'cattle-breeder,' *gaodhana* (=Skr. *godhana*) 'possession of cattle,' *vāstra* or *gaoyaoiti* (=Skr. *gavyūti*) 'pasture.' The star-yazata Tishtrya and the genius Verthraghna appear in the Avesta as gold-horned bulls (like Indra, the Vritra-killer, Parjanya and others, in the Rig-veda). Yt. VIII, 16; XIV, 7.

[3] Yt. X, 38.

[4] Perhaps the expressions *gao-azi* and *gao-vazi* (derived from root *az*=Skr. *aj*, and from root *vaz*=Skr. *vah*) must denote the double use of cattle as beasts of draught and beasts of burden. The inhabitants of the Pāmir in our days employ yaks for bearing loads.

[5] *Vide* p. 228 of *OKA*.

written especially according to the ideas and in the interest of a settled population of farmers and herdsmen. But cattle-breeding really demands a life by far more sedentary than the breeding of restless, migratory sheep and goats. The latter are, therefore, the peculiar beasts of nomadic tribes of herdsmen, whereas horned cattle form the property of settled farmers.

The descriptions of the Avesta must, therefore, refer to a certain portion only of the population, but the real conditions do not completely correspond to the picture as we see it. Although we have no grounds for supposing that cattle-breeding was in the old ages in as low a state as it is at present in Central Asia, yet it was probably restricted to certain regions and to a small portion of the people. Sheep and goats were certainly not less cared for than now, since the country is naturally well adapted to the rearing of them. They were certainly more liked and valued than might appear from the texts of the Avesta.

Natural pastures are not wanting in the country of the Avesta people. They are found in the valleys of the high mountains, nay, even on the Pāmir. Many of them could not be brought under tillage on account of their situation. The desire to profit by them for cattle-breeding was enhanced by the fact that there was no abundance of soil easy to till, and, therefore, even the smallest possible portions had to be employed for growing fodder.

So it was natural that pastoral habits were also developed among the sedentary and farming population who kept cattle as well. As the inhabitants now living in Wakhān drive their herds in summer to the neighbouring steppes of the Pāmir[1], just as the nearest mountain regions serve in summer as a pasture-ground to the inhabitants of the Yāghnōb; so it was certainly even in olden times. A sojourn in the brisk mountain air and the wholesome nutritious pasture could not but cause the herds to thrive.

This system of pasturing has of course no resemblance

[1] Gordon, 'Pāmir,' p. 136; Schuyler, 'Turkistān,' p. 278. Cf. particularly, Wood, 'Journey,' p. 210: 'In the summer, the women, like the pastoral inhabitants of the Alps, encamp in the higher

with the continual and regular change of feeding-grounds, as it was, and is, customary among nomadic and semi-nomadic tribes. Permanence of abode was by no means prejudiced by it. The owner of the farm remained with the greatest part of his servants in the valley and followed agricultural pursuits. Only the *shepherds* or the *herdsmen*[1] accompanied the animals.

On the mountains the cattle remained during the night in the open air, and were only penned in by fences or hurdles[2]. The dogs took care that no thieves or wolves attacked the herd or dispersed it. 'If anybody,' it is therefore ordered, 'wounds a dog that watches cattle, or cuts off his ear or foot, and if then a thief or a wolf comes unperceived upon the herds and carries off ten head of cattle, he [i.e. the man who injured the dog] must give compensation according to the amount (of the damage)[3].'

The wolf being certainly the most terrible enemy of

valleys interspersed among the snowy mountains, and devote their whole time to the dairy. The men remain on the plains, and attend to the agricultural parts of the establishments, but occasionally visit the upper stations, and all speak in rapture of these summer wanderings.'

[1] *Zaotare* 'driver,' Ys. XI, 1; *vāstare* 'herdsman,' Ys. XXIX, 1, according to the very probable conjecture of Westergaard.

[2] *Ashta* 'hurdle' = Skr. *asta*. Hence Vd. XIV, 17: 'On twice ninety hurdles, whose fencings (*harethra* 'fencing,' from rt. *har*) are no longer useful, solid enclosures shall be raised.'

[3] Vd XIII, 10, *dasa* 'ten,' is apparently a signification of an unsettled plurality. 'Herd' is expressed in this passage by the word *gaetha*, the meanings of which have developed, as I think, in the following way:—

Original meaning:
'Possession, homestead, household.'

| | |
|---|---|
| Livestock, herds, flocks. | Estate, premises, fields. |
| Animals, world generally. | People living on the premises, colonists. |

Below I shall demonstrate the different meanings of this word by quotations.

grazing cattle[1] on pasture-grounds, is very justly called the 'herd-killer[2].' For greater security the herdsmen not unfrequently remained with the herds even during the night, and the fires that were then lit[3] served as well to warm their bodies as to scare away these unwelcome visitors.

In winter the pastures are inaccessible on account of the deep snow. Already at the beginning of October the cattle were invariably brought back into the valleys, and now the feast of 'driving in'[4] could be celebrated. It commenced at the same time as the winter half of the year

It was necessary that the cattle should be sheltered in safe and substantial stables during the cold months and that the necessary fodder should be provided.

As the Avesta enjoins the expiation of different faults by constructing roads, bridges, canals and divers useful works, so likewise does it order it by the erection of *stables*. Several precepts, therefore, are given respecting the size and fashion of the building, which, it is to be regretted, we cannot fully understand[5]. Besides the stables for cattle, stables for horses and camels are also mentioned, and, moreover, pens for sheep and goats[6].

In order to feed the cattle during the winter in their stables it was necessary to cultivate grass with a view to

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[1] *Yatha · vā · vehrkăm · azrō-daidhīm · gaethăm · avi · frapataiti* 'as a wolf (*vehrkō*!) that dashes into the feeding herd on the pasture-ground.' I refer *azrō-daidhīm* to *gaethăm* and trace *azra* to Skr. *ajra* 'fields' (Grassman's *Wtb. sub voce*).

[2] *Gaethō-jan* 'beating the herds.' [3] Vd. VIII, 94

[4] *Ayāthrema*, see above, p 150, and also p 146 of *OKA*.

[5] *Nmānem · gavayanem* (a house for cows) . . . *chithīm · nisirinuyāt*, Vd. XIV, 14 The stable shall be: *dvadasa · vītāra upema, nava · vītāra · madhema, khshvash · vītāra · nitema*; according to Darmesteter: 'twelve *Vītāras* in the largest part of the house, nine *Vītāras* in the middle part, six *Vītāras* in the smallest part. Cf. Spiegel, *Comm.* vol. i, p. 342; de Harlez, *Av. tr.* vol. i, p. 224, n 4

[6] *Gavō-stāna, aspō-stāna, ushtrō-stāna* (Skr. *gosthāna, açva-sthāna, ushtra-sthāna*), *pasush-hasta* (*hasta* from the root *had* 'to settle'). It must not be overlooked that the stables for flocks have a different denomination from those for herds! Cf. Yt. X, 86. In Yt. V, 89 the hurdle is called *pasu-vastra*; see p. 48, n. 1 of *OKA*.

providing a store of hay. But there can be no doubt that stall-feeding was limited to the utmost possible degree. Grass is considered an object of farming as well as corn and fruit-trees [1]. Wherever the natural fertility was not sufficient, the productiveness of the meadows was increased by artificial irrigation [2]. The harvesting of hay took place in the month of June, just as in all countries of a moderate temperature. Midsummer-day is, therefore, the time of grass-mowing [3].

Several species of horned cattle were distinguished. There seem to have been five [4], however, more specific statements cannot be made from our texts. It would be very interesting to learn whether the *yak* was known to the Avesta. I cannot think it probable from the names by which it is now denominated in the Pāmir-dialects [5]. The yak, besides, is found more frequently in the territories of Eastern Turkestān, particularly in Tibet. It is very doubtful whether it ever was a native of the Pāmir [6]. But since it is at present on the Pāmir a domesticated animal of exceeding value, it will not seem to be superfluous to say something about it here according to Wood's description [7].

[1] Vd. III, 4–5.

[2] The produce of the meadows is called *vāstrem-beretem* or *vāstrō-beretem* or *beretō-vāstrem* (Vsp. I, 9; II, 11; Vd. II, 24). The artificial laying out of a meadow seems to be denoted (Vd. XV, 42) by *uz-dā*.

[3] *Maidhyōshema vāstro dātainya*. See above, p. 150, and also p. 146 of *OKA*.

[4] Hence, I think, the epithet *pañchōhaya* (Yt. XIII, 10). Another appellative is *pouru-saredha* 'consisting of many species.'

[5] It is called (Tomaschek, *Pamirdialekte*, p. 32) either *staur* (Av. *staora*) or *dzugh* (from the root *yuj* 'yoke-beast'). In the Avesta *staora* is a collective appellation for all kinds of animals which are driven in herds. In Vd. VII, 41 it denotes a single beast. But here also we must not suppose that the yak is denoted. The passage treats of an *upema*, *madhema* and *nitema staora*, by which names probably are meant a camel, a horse, and an ox.

[6] Faiz-Bakhsh relates that the wild yak is met with on the Pāmir (in Yule, 'Essay' LXIV); by Gordon, on the contrary, this is expressly denied ('Pāmir,' p. 159).

[7] 'Journey,' pp. 208–211. Wood remarks that in Badakhshān

The yak is about double the size of an ox. Shaw, indeed, killed in Tibet an old yak which measured 10 ft from the nose to the root of the tail, and was 5½ ft. high at the shoulder[1]. Its colour is generally black, white ones are rare Its hair is exceedingly thick and long, hanging down to the ground on its sides The tail is tufted and its hair extremely fine; white tails, as is known, are greatly valued in India.

The home of the yak is in the mountains. Wherever the thermometer does not rise above freezing-point, the climate is suited to it, in warmer districts it will degenerate and die off[2]. In summer, therefore, the yak-herds are driven from the low-lying regions into the valleys surrounded by snow-capped mountains. The women follow these herds, while the men remain in the valley to work in the fields. Now and then they go to their herds and speak with rapture of their wanderings on the mountains.

The yak is chiefly used for riding and carrying loads. Wherever a man can walk, the yak may be ridden. It is to the inhabitants of the Pāmir countries what the reindeer is to the Lapps of Northern Europe. Like the elephant, it possesses a wonderful knowledge of what will bear its weight. After a fresh fall of snow, travellers make the yaks walk at the head of the caravan. They are then sure that these beasts will avoid, with admirable sagacity, the hidden clefts and crevices. At the same time they are the pioneers of the caravan, for which they make an excellent road by leading the way.

The milk of the female is excellent, though its quantity

and Wakhān the yak is called *kāsh-gau* 'ox of kash.' Here, therefore, it is reputed a bovine animal.

[1] *Reise*, p. 75.

[2] Wood relates that he bought a yak in Ishkāshim for Dr. Lord, and sent it to Kunduz under the care of two trustworthy men. Though it was still winter, the yak died on the way. Several years before a nobleman of Afghānistān succeeded in bringing two yaks as far as Cabul. But here also the climate was not cold enough. They died in the beginning of spring. At present, it is true, domesticated yaks of Chinese origin are to be met with in our Zoological Gardens.

is not so great as that of the common cow. The flesh of the yak is also eaten. Its hair is worked into carpets or cloth.

THE HORSE.

As cattle are the principal domestic animals of the farmer and herdsman, the horse might well be said to be of an aristocratic character[1]. He is chiefly esteemed by the warrior whom he serves on his campaigns as a friend and companion in his battles and victories.

Hence the word *aspa* 'horse' is in the Avesta dialect of frequent use in the formation of proper names. These names mostly denote personifications of the legendary heroes of Eastern Irān. I mention *Erzrāspa* 'having ruddy horses,' *Kersāspa* 'having lean horses,' *Arvataspa* 'master of warlike horses,' *Hitāspa* 'driving harnessed horses,' *Huaspa* 'having good horses,' and so on. There might be added a number of similarly formed names from Western Irān, transmitted in Oriental writings, as Prexaspes, Sataspes, Hystaspes.

The horses serve not only men but also [*figuratively*] the celestial *yazatas*. Apãm-napāt, the genius of the clouds, and the *sun-yazata* drive warlike horses. The car of Ashi, likewise, of Srausha, and of Usha 'the Dawn,' is thought to be drawn by [*heavenly*] horses[2]. In the shape of light-red horses appear the genii Tishtrya and Verthraghna [3], sometimes also represented as clear-coloured bulls. The car of Mithra is drawn by horses of the same colour :—

[1] The 'horse' is plainly *aspa*. The stallion is called *aspō-arsha* = Skr. *açvaḥ · vṛshā*, the mare *aspi* or *aspō-daenu*. A special or, as it seems, more poetical expression is *erenava* (Ys. IX, 22) It is translated into Pahlavi by *asp*, and certainly signifies 'runner.' Geldner (*Metrik*, pp. 130–131) believes *erenava* to be the prize given in chariot-races.

[2] Cf the epithets *aurvat-aspa*, Yt. II, 9; VI, 1 and 4; Ys. XXII, 24; and *reñjat-aspa* 'driving nimble, fleet horses,' Gāh V, 5. According to Weinhold (*Altnord. Leben*, pp. 48–49), horses are also considered to be gods by the old Germans of the North.

[3] Yt. VIII, 18; XIV, 9. The opponent of Tishtrya, Apausha, appears, however, in the shape of a black horse; *Vide supra*, p. 138.

'Whom draw heavenly coursers, red, light, seen far and wide, blessed, active, fleet, obeying the heavenly will[1].

The Avesta people distinguished horses especially by their colour. First in order stand the white, besides, fallow and reddish-brown, dark-brown and black horses are specified[2]. Evidently white horses are reputed sacred, white being the colour of light. Hence they are chiefly used by the *yazatas*[3], such as Ardvi-sūra. Of Mithra also it is said:

'His chariot is drawn by four horses, white, uncoloured, eating heavenly food, immortal[4].'

The Persians are expressly stated by Herodotus to consider white horses as sacred[5]. And this custom can be traced also to people of other than Irānian race.

In the Vedic hymns the fire-god Agni is compared to a white horse. White is the colour of the horse which is given to Pedu by the Açvins, the Indian *Dioscurides*. In a poetical way the sun himself is called a white horse that carries the goddess of dawn up the sky:

'Bringing the eye of the gods, conducting the white beautiful steed, the happy Ushas appeared, decorated with rays, bestowing gifts, presiding over the universe[6].'

The Hellenes, likewise, regarded white horses as sacred. They are chiefly used by light and sun-gods. The Dioscurides ride light-white steeds, and horses of the same colour are harnessed to the car of *Eos* or Dawn[7].

By the Germans white horses were valued above all others; generally they were even forbidden to be used for worldly purposes. They were consecrated to the gods

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[1] Yt. X, 68 and 136. Mithra is, therefore, called *aurushāspa*.

[2] *Spaeta* or *spaetita* = Skr. *çveta* 'white;' *zairi* = *hari* 'fallow;' *erezra* = *ṛjra* 'light-red;' *aurusha* = *arusha* 'chesnut;' *syāva* = *çyāva* 'bay;' *sāma* 'black.'

[3] Yt. V, 13. [4] Yt. X, 125. [5] Herod. I, 189.

[6] Rv. VII, 77. 3; cf. Grassmann's *Wtb.* under the word *çveta*, Zimmer, *AiL.* p. 231.

[7] Preller, *Griech. Mythologie*, I², 335; II², 191.

and reared in sacred groves. Kings only were allowed the special privilege of riding white horses[1].

Not less care was necessary in breeding horses than in breeding cattle. The slightest neglect was regarded as a great offence, and followed by punishment. In the Avesta the horse itself is made to pronounce a curse against the neglectful master:

> 'Never more shalt thou harness horses, nor ride on horseback, nor yoke horses to the carriage, thou who askest not strength for me in numerous assembly, in populous companionship[2].'

The old Irānian, especially the warrior, frequently repeats his desire to possess horses. The warlike hero implores the *yazatas* to give strength and endurance to his team. And the divine beings bestow 'herds of horses and wealth in horses' on those that offer sacrifice and veneration[3]. Horses are the pride of the heroes and their dearest and most cherished possession:

> 'Thee, O Anāhita! valiant heroes implore to grant them fleet horses.'

> 'To her, Anāhita, offered the Hvovides, to her the Nautarides; those asked for riches, these for the possession of fleet horses. Soon were the Hvovides blessed with riches; but the Nautaride Vishtāspa was in our country owner of the swiftest horses[4].'

Among the qualities of the horse his swiftness is the most prominent. In a poetical manner he is, therefore, classed with the wind, clouds, fog, and winged birds[5]. Next in estimation is his endurance, and, justly, also his keen sight. The stallion is able to see a horse-hair lying

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[1] Tacitus, *Germ.* IX, 10; Grimm. *Deutsche Mythologie*, II[4], 552–553; Weinhold, *Altnord. Leben*, p. 47.

[2] Ys XI, 2. *Ebenda* 1, *vide* the curse of the cattle. Compare to this Geldner, *Metrik*, § 116.

[3] *Aspyām · īshtīm, aspyām · vāthwām*—Yt. VIII, 19; cf. Yt. X, 3 and 11.

[4] Yt. V, 86 (*āsu-aspya*) and 98. Cf. Yt. XIII, 52.

[5] Ys. LVII, 28.

on the ground in the most dark, tempestuous, and rainy night, when the sky is covered with clouds [1].

He is chiefly employed, as already mentioned, in warfare Joyfully snorting [2] he draws the chariot of his master into the thick of the fight. He is no less esteemed in the chariot-race; for here also he bears the hero to honour and glory.

Chariot-races were without doubt customary among the Avesta people Husrava applies to Anāhita, praying: 'Grant to me that I may drive, among all the teams, the foremost on the long race-course [3].' Wherever a hero asks strength and endurance for his team, we may consider that he thinks of chariot-races as well as of battles. But the remarks of the Avesta are so few that it would be superfluous to treat of the sports of the people of Eastern Irān in a special section.

Among the old Indians chariot-races were far more in favour than among the Avesta people. In the Vedic period they were carried on with peculiar spirit. Numerous passages of the Rig-veda, nay, whole songs treat of this chivalrous sport. In later times they fell into complete disuse because the people degenerated under the influence of sacerdotal dominion and grew still more unwarlike [4].

The use of chariots, particularly in battle, was a general custom among the Eastern Irānians as well as the Indians of the Vedic, and the Achaians of the Homeric, periods. But it was also usual to ride on horseback. It is of course evident that the nomad hordes of the desert never used any vehicle, but always went on horseback. Mithra, therefore, is said to batter down with his club, men and horses of

[1] Yt. XIV, 31 and XVI, 10 Compare with this what is asserted as a characteristic of the horse by Scheitlin (in Brehm, *Thierleben*, II, 354 seq.).

[2] *Ravō-fraothman*, Yt. XVII, 12. As a charger he is called *aspa-aurvat* or simply *aurvat*=Phlv. *asp-i-kārīzār*—Ys. XI, 2.

[3] Yt. V, 50; XIX, 77. The length of the race-course *charetu* or *chareta* (Phlv. *asp-rās*) seems to have been employed, like the Greek στάδιον, for measuring distances. See Vd. II, 25 and 33.

[4] Zimmer, *AiL.* 291.

the enemies and to chase away men and horses[1]. These enemies are apparently nomads, hardy riders who, as it were, grow up together with their horses and conquer or perish together with them.

Here I again call attention to the curse of the horse against the neglectful owner. 'Nor longer shalt thou ride henceforward on horseback.' In the Avesta the warriors are also said to pray to the *yazatas* 'on the backs of their horses'[2] to grant strength and endurance to them and their coursers. This evinces that riding (on horseback) was known to all classes of the people. Riding was probably resorted to when great distances were to be traversed in the shortest possible time. The journey which a well-mounted rider was able to perform in a day was, therefore, made use of for a certainly primitive standard of measure[3].

The predilection of the Vedic Indians for the horse and their passion for chariot-races can hardly be explained from the conditions of Indian life[4]. In India the horse does not thrive, as even Herodotus expressly states[5]. In later time horses were brought from the country of the Bālhika, i e. from Bactria[6].

Here again we surely find in the Vedic culture a relic of former times. This custom originates in the period in which the Arians still encamped on the northern slope of the Paropamisus. Here, in the regions bordering on the desert, the land is, more than elsewhere, adapted to the breeding and training of horses. Here we find the requisite fat pastures and free open plains which serve for exercise. In these regions horse-breeding was at all times cultivated in great perfection.

I will not speak at length of the breeding of the Turco-

[1] *Hō · paoiryō · gadhãm · nijaiñti * aspaecha · paiti · vīraecha * hathra · tarshta · thrāoghayeiti * uvaya · aspa-vīracha.* Yt. X, 101.

[2] *Bareshaeshu · paiti · aspanãm.* Ys. X, 11.

[3] So it is asserted (Yt. V, 4) of the canals and branches of Ardvisūra or the Oxus: *kaschitcha · apaghzhāranãm * chathware-satem ayare-barãm * hu-aspāi · nairẹ̄ · baremnāi*, 'and each of the water-courses is a journey of forty days for a good rider.'

[4] *Vide* also Roth, *ZddmG.* xxxv, p. 686. [5] Herod. iii, 106.

[6] Cf. *B. R.* under the words *bālhi* and *bālhika.*

man horses, whose admirable swiftness and incomparable endurance are praised by every traveller without exception[1]. It is certain and it is affirmed by national tradition that the Turcoman horses, though on the whole indigenous, have a considerable admixture of Arabian blood. What is certainly of greater importance is that the high value which the Median horses had, in ancient times, in the eyes of a part of the Avesta people, was established, without doubt, on Median ground. Special praise is given to the horses of *Nisaa*, which must not be confounded with the *Nisaya* of the Vendidad. They are already mentioned by Herodotus, and Arrian and Strabo agree with his assertion[2].

The Eastern parts of Irān also are excellently adapted to horse-breeding. Curtius relates that Bactria abounded in good horses. One tribe of the Bactrians seems to have had the name *Zariaspi* 'with fallow horses,' and this name was given afterwards to the capital. The chief forces of the Bactrians consisted of their dreaded horsemen[3].

Horse-breeding is still successfully carried on in Balkh[4]. The horses of Herāt are likewise greatly valued. They are small, indeed, but strong and hardy. A great number of them are exported every year[5]. In short, we may justly say that all Irān is adapted to horse-breeding, and that the ground and soil are so conditioned that the inhabitants must have been attracted to it at all times.

[1] Ferrier, *Voyages*, I, pp. 183–185; Vámbéry, *Reise*, p. 368; the same, *Skizzen*, p. 198; McGregor, 'Journey,' I, pp 267–268; Grodekoff, 'Ride,' 128. So too Fraser, Conolly, Abbott in the compilation of divers notices by Marvin, *Merv*, pp 162–176.

[2] Herod. iii, 106, vii, 40; Arr. vii, 17, Strabo, pp 529–530. Cf. the excursion in Ritter, *Asien*, IX, p. 363 seq. Darius, too, in an inscription at Persepolis (H. 8–9) praises the abundance of horses in his country.

[3] Curtius, IV, 12, 6; V, 8, 4; VII, 4, 26 and 30; cf. Forbiger, *H. a. G.* II, 555 seq.; Kiepert, *A. G.* § 54 and 59, note

[4] Elphinstone, 'Kabul,' vol. I, p. 466. Horses in Kunduz according to Wood, 'Journey,' p. 143.

[5] Elphinstone, 'Kabul,' vol. I, p. 266; Malleson, 'Herāt,' p. 92. According to Wood ('Journey,' p. 249) horses are rather rare on the upper Oxus. In the upper Zerafshān they are, according to Schuyler (*Turkistān*, I, 278), replaced by asses.

We may assert even more. It is very probable that Central Asia is the original home of the horse, that here man began to compel to his service this noblest of all domestic animals. From the broad expanse of this continent, whose gravelly and sandy steppes afforded a free space to wander in, the horse went down, on all sides, through the high mountains of Northern India, into the valleys of Turkistān, into the tracts and plains near the Oxus and the Jaxartes Even in our days numerous herds of horses, called Tarpans, rove freely about in Central Asia It cannot be stated with certainty whether they have returned to the wild state or whether they are to be regarded as the wild sires of our domesticated animals [1].

### The Camel

The camel is found all over Central Asia In our own days it is extensively reared in the territories which must have been the home of the Avesta people For the inhabitants of many countries it is even more useful than the horse itself; in desert districts it is almost indispensably necessary [2].

The camels of Bokhārā are highly renowned Here, as well as in Khiva and in the other Khanates of Central Asia, both the single and the double-humped species are bred The latter is especially the domestic and royal animal of the wandering Kirghiz. On account of its great fleetness and hardihood it is employed in the Turcoman deserts for the special purpose of carrying express messengers [3].

[1] Brehm, *Thierleben*, II, p 335; Hehn, *Culturpflanzen*, p. 20 seq Compare besides Middendorff, *Einblicke in das Ferghanah-Thal*, p. 264 seq. Mém. de l'Ac. de St. Pétersbourg VII sér t. xxix No. 1.

[2] An account of the camel and its distribution is given by Ritter, *Asien*, XIII, p. 609 seq. Compare besides Brehm, *Thierleben*, II, p. 399 seq ; and especially Polak, *Persien*, II, p. 98; Spiegel, *E. A.* I, p. 260.

[3] Burnes, 'Bokhārā,' II, p. 210; III, p. 153; Khanikoff, 'Bokhārā,' p. 202; Vámbéry, *Reise*, pp. 368–369, and also *Skizzen*, p. 198. Schuyler, *Turkistān*, I, p. 130: 'Of course one sees everywhere in the streets numbers of camels.' Middendorff, *Ferghanah*, pp. 293 seq.

In Afghānistān the two-humped camel is oftenest seen. It is also called the Bactrian camel, because it seems to be a native of the districts in the North of the Hindukush and is chiefly found there[1]. The breed in particular request is that of Andkhui, a variety called *Ner* The Ner-camels are conspicuous by the thick hair which grows down from their necks and breasts, by their slender form and uncommon strength[2].

The inhabitants of the Pāmir also and of the valleys and tracts on the Upper Oxus cultivate the camel as a domestic animal[3]. The two-humped camel of the Pāmir-Kirghiz is described by Wood. It is not so ugly as the Arabian camel, but combines with the good qualities of the latter a noble carriage in which it is surpassed only by the horse. A Kirghiz horde consisting of a hundred families, whose encampment was passed by Wood between Ishkāshim and Kalai-Panja, had, besides 2000 yaks and 4000 sheep, no less than a thousand camels of this description.

The nomads of Central Asia in particular esteem the camel above all other domestic animals, almost to the point of adoration. We cannot wonder at this when we consider its great strength, patience, and the trifling cost of maintaining it. Fed by a few thistles which are despised by other beasts, it wanders for weeks, nay for months, across the desert without being fatigued. Moreover, it is so docile and obedient, that a child is able to govern a whole troop of these beasts by a single word[4].

In the breeding season the character of the male camel is entirely changed. It grows wild, stubborn, vicious and intractable. It becomes dangerous even to its human masters, and there are instances in which men have been bitten to death by such mad camels[5].

The Eastern Irānians of antiquity kept the camel[6] as a

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[1] Elphinstone, 'Kabul,' vol. I, p. 227; Stein, *Petermanns Mittheilungen*, 1879. 24. [2] Vámbéry, *Reise*, p. 213.

[3] Gordon, 'Pamir,' p. 113; Wood, 'Journey,' pp. 212–213, 246.

[4] Vámbéry, *Skizzen*, p. 54. [5] Schuyler, *Turkistān*, I, p. 20.

[6] *Ushtra* 'camel' = N.P. *shutur*. The corresponding expressions in the Pāmir dialects are found in *Tomaschek*, p. 31.

domesticated animal as well as the tribes now dwelling in the plains on the Sīr and Amu. It is already mentioned even in the Gāthās:

'That I ask of Thee; give me truly answer, O Ahura!
When shall I get justly and rightly my reward,
Ten mares with their stallions and a camel[1]?'

As far back as we can in general trace the culture of the Avesta people in past times, they must have attended to the breeding of camels. Yet the contexts lead us to suppose that in the earliest times the camel was more valued than the horse, or at least was less common.

In the later Avesta the camel ranks, wherever the domestic animals are regularly enumerated according to their value and importance, between the horse and the cow, standing before the latter and after the former[2]. Yet there are also exceptions For curing the wife of the master of a village a cow must be given as fee to the physician, for curing the wife of the chief of a district a mare, and for the wife of the governor of a province a she-camel. The latter is here, indeed, more highly priced than a horse or cow[3].

Camels were no less desired by the old Irānians than herds of cattle and horses. A Tūrānian seems to have been praised for possessing 700 camels[4]. If this passage is urged, it will perhaps prove that the less sedentary Tūrānian tribes, the nomads, devoted special attention to the training of this useful animal.

How much the camel was esteemed in old Irān may be seen from the fact that a great deal of personal names are formed by combination with *ushtra*. I mention *Arava-ushtra* 'having wild camels,' *Vōhu-ushtra* 'having good camels,' and *Avāraushtra*, but more than all the name of the prophet *Zarathushtra* himself, and that of his friend and follower *Frashaushtra*.

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[1] Ys. XLIV, 18.

[2] Vd. XXII, 3–4, 20: *aspa, ushtra, gao, anumaya.*

[3] Vd. VII, 42. Cf. also Vd. XIV, 11.

[4] Yt. IX, 30.

A full and particular description of the camel, less poetical indeed, but rather circumstantial, is given in the following passage of the Avesta:

> 'A fourth time came driving Verthraghna, whom Ahura had created, in the form of a load-bearing camel, a biting, swift-footed, a submissive, rambling, a hair-covered, dwelling with man; that of all productive males has the greatest power and the greatest courage; that roves among the females; for those (females) are best protected, whom a burden-carrying camel protects; a slender, bony, strong-humped, a . . . gay-looking, courageous, a stately, tall, mighty; that casts up whitish foam towards its head in its courage and its strength[1].'

Before I finish this section I must allude to a remarkable matter. To the old Irānian word for 'camel' corresponds, in the Indian language, *ushtra*, which is found both in Vedic and in later literature. Here it has, agreeably to the dialect of the Avesta, the signification of 'camel[2];' in the Rig-veda, however, it seems to mean rather a buffalo (or humped ox), as we should, indeed, conclude from the context of certain passages.

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[1] Yt. XIV, 12–13. The epithets are the following: (1) *Vadhairi.* We might at first recall to mind the Skr. *vadhri* 'castrated,' and regard the *a* between *dh* and *r* as a Svarabhakti vowel. But this suggestion is expressly excluded by the third strophe. I therefore adhere to the explanation of Geldner (*Metrik*, p. 8 n.). (2) *Dadãsu* 'biting.' (3) *Aiwi-tachina*, literally, 'running to and fro,' hence 'swift.' (4) *Urvat* 'friendly, submissive.' (5) *Frasparena*, from *spar* = N.P. *sapardan* 'pede calcare, viam terere' ('to beat the road by the foot or spur'). (6) *Gaethu* 'hairy' (?) = *gaesu* (see my Manual under this word). (7) *Mashyō-vag̃ha*, from *m.* + *vãgha* from root *vag̃h* = Skr. *vas* 'to dwell.' (8) *Ash-bāzu* 'with strong fore-feet.' (9) *Stui-kaofa* 'with high, strong hump.' (10) *Smarshna* (?). (11) *Daema-jira.* (12) *Sāra* 'valiant,' from root *sā* = Skr. *çā* 'to sharpen'; cf. German *Schneidig* (sharp). (13) *Raeva.* (14) *Bereza.* (15) *Amavat.* To these are to be added from Yt. XVII, 13 *Uzyamana* · *zemat* 'starting from the ground,' *ash-manag̃h* 'courageous,' and *peretamana* 'warlike.'

[2] *Vide B. R. sub voce.*

Sometimes one may hesitate between these two meanings in the Vedic songs [1]. Thus it is in the Dānastutis, in which the poets praise the gifts with which they have been honoured by princes. Here the *ushtras* are enumerated among the gifts along with horses and cows [2]. But there can scarcely be any doubt that buffaloes are meant, when the *ushtras* are said to walk by fours under a yolk [3] And the same meaning I think correct whenever Pushan, chasing his enemies before him, is compared to an *ushtra* [4]. For elsewhere in the Rig-veda the bull is the symbol of untamed strength and force [5].

From the change of signification in this single word we may again derive a portion of the history of civilization. The Indo-Irānian tribe certainly denoted by *ushtra* only the camel. On the northern slope of the Hindukush or still further to the North he may have learned to breed and train this domestic animal. With the Irānian people who remained in the original seats, it preserved at all times its high importance and its old name But the Indians took the camel with them when wandering into the low plains of the Indus and its five tributaries. Here it must have become more and more rare, because it was not found in a wild state in this neighbourhood. The number of the camels which they had brought with them decreased more and more, for in India the camel thrives only in a few tracts which are specially favourable to its increase, as in Mārwār [6]. The losses could not well be replaced by beasts tamed anew.

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[1] Ludwig, indeed, in his translation of the Rig-veda, renders *ushtra* at one time by 'camel,' at another by 'buffalo.'

[2] Rv. VIII, 5, 37; XLVI, 22.

[3] 'Up to the heavens reached *Kakuha*, who gave me four-yoked *ushtras*; by glory the people of Yadu.' Rv. VIII, 6, 48.

[4] Rv. I, 138, 2. Here Ludwig (Rv. I, 154) translates *ushtra* by 'camel.'

[5] In Rv. VIII, 46, 31 the *ushtra* is said to bellow. The word *krad*, employed in this passage, generally designates the bellowing of bulls and the neighing of horses.

[6] Lassen, *Indische Alterthumskunde*, I[2], 349. In the upper part

In the Zebu or hump-backed bull which is a native of India the Vedic Arians found a substitute for the camel which continued to die out Like the camel it became the favourite beast of burden, and was finally known by the same name *ushtra*.

But the remembrance of the camel and its useful services was not lost. Perhaps the species had never become entirely extinct, though surviving only in a few individuals. In a later time it became again more common because camels began to be introduced from the bordering districts of the West. In this way the old name, which had in the Vedic period an unsettled meaning, but the original signification of which had never been wholly forgotten, acquired new importance, and the camel was again denominated by the name *ushtra* as before.

## The Ass.

Among the domestic animals of the Avesta people the ass is also mentioned, though only in a single passage of our texts. In usefulness it stands next to the horse and camel. A female ass is the fee which must be paid to a physician who has succeeded in healing the wife of the chief of a family [1]. For curing ladies of higher rank a cow, a mare, or a female camel must be given.

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Among the Indians of the Vedic time also, the ass was greatly valued as a domestic animal. It was mainly employed for carrying heavy burdens; but the male ass was also yoked to carriages [2].

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of India the camel must have existed in pre-historic times. In 1834 the bones of this animal were found in a fossil state on the spurs of the Himālaya ('Journal of the Asiatic Society of Bengal,' 1835, vol. iv, pp. 517, 694, in Ritter, *Asien*, XIII, p. 634).

[1] Vd. VII, 42: *kathwa-daęnu*. With *kathwa* compare, from the Pāmir dialects (*Tomaschek*, p. 31), the word *kuāt*, which means 'the colt of an ass' in Wakhī.

[2] Zimmer, *AiL*. pp. 232–233.

At present great attention and care are paid to the breeding of asses in Persia and Turkistān. This animal is, in our northern countries, not seldom headstrong, lazy and wilful, though there is no reason at all for making him the type of dulness and stupidity. In southern countries he makes a more favourable impression. There he is a fine and sturdy beast, and is besides no less active than enduring [1].

Particularly numerous and renowned are the asses of Bokhārā and Khīva [2]. Every year many are brought to Persia, Bagdād, Damascus and Egypt by the Hājis. In Tāshkend they are nearly as common as horses. Here they are of small stature and of white or gray colour; they are able to carry heavy loads. In Khokand, it is true, they are very seldom met with, but on the upper Zerafshān, where horses are rare, they are used as beasts of burden [3].

It is not at all improbable that it was in Central Asia that the ass, like the horse, was first brought under the power of man. At least the sandy and gravelly steppes of Central Asia are the original home of the *onager* or wild ass. He is a most handsome and swift animal, very shy, and, therefore, very difficult to hunt [4]. Great herds of wild asses roam about near the Aral and Caspian and in the deserts in the North of the Garmsil, according to the reports of travellers [5].

## Sheep and Goats.

We know already that greater value and importance are attributed by the Avesta to the breeding of cattle than to

[1] Brehm, *Thierleben*, vol. II, p. 365 seq.

[2] Khanikoff, *Bokhārā*, p. 202; cf. Vámbéry, *Skizzen*, p. 199; *idem*, *Reise*, p. 369. Regarding the Persian ass, see Spiegel, *E. A.* vol. I, p. 260. Cf. Middendorff, *Ferghanah*, p. 281.

[3] Schuyler, *Turkistān*, I, pp. 130, 278.

[4] Brehm. *Thierleben*, vol. II, p. 361 seq.

[5] Vámbéry, *Reise*, pp. 96, 98; Ferrier, *Voyages*, vol. II, p. 294, and other passages. Cf. p. 98 of *OKA*.

that of sheep and goats [1]. Probably, whilst cattle were the chief property of the settled portion of the people, nomadic or semi-nomadic tribes devoted their time to breeding small cattle, viz. goats and sheep.

The usefulness of goats and sheep was certainly not unknown to the Avesta. Their milk was occasionally drunk, their flesh was doubtless eaten, and their hair and wool were made into cloth [2].

It is easy to explain why the sheep is the symbol of shy timidity. The wolf is its most dangerous enemy. As a sheep is afraid of the wolf, the demons are afraid of the soul of a pious dead person [3].

The old Irānian farmers kept, not only their herds of cattle, but also their flocks on the pastures of the neighbouring mountains during summer. In autumn they returned into the valleys and were here sheltered against the severity of frost and snow in warm penfolds during the whole winter time [4]. After their return at the end of September the rams were allowed to go to the ewes [5]. The lambs, then, were born in the beginning of March, and were able, when they had passed a summer on the pastures and grown vigorous, to endure the hàrd Irānian winter with less risk than lambs born in July or August.

The breeding of flocks flourishes in full vigour in the districts of the Sīr and the Amu and in Afghānistān even in our days [6]. To a great extent it is favoured by the climate and the natural conditions of the soil. On account of their being so prolific and so easily driven, sheep and

[1] Sheep *maęsha*, ewe *maęshi · daenu*, or *maeshi* alone, ram *maesha · varshni*, goat *buza* or *iza*.

[2] Vd. V, 52; VII, 15; for cloth made of goat-hair we have *vastra · izaęna*, *vide* p. 224 of *OKA*.

[3] Vd. XIX, 33. Cf. *Aogemadaechā*, p. 19; Yt. XXIV, 27.

[4] Cf. *supra*, p. 171.

[5] Cf. *supra*, p. 150; Roth. *ZddmG*. vol. xxxiv, pp. 704–705.

[6] In Persia also mutton is in favour and cloth is made from the wool of sheep and the hair of goats. Spiegel, *E. A.* vol. I, pp. 260–261; Polak, *Persien*, vol. II, pp. 96–98.

goats are much affected by wandering herdsmen [1]. Their transport causes no difficulty, even marches of considerable length are by no means hurtful to them. They easily mount the highest valleys and defiles of the mountains, and even poor pastures, difficult of access, where cattle would starve, are sufficient for their sustenance

Besides, they more easily resist the cold of winter than cattle, and by no means require such careful and regular tending. The inhabitants, therefore, of rugged and barren mountainous tracts in which the winters are severe and long, always rear them in preference to any other domestic animal.

So sheep and goats are the most valued animals in the mountainous regions of Eastern Irān. They are found on the Pāmir and in the valleys on the Upper Oxus, in Sirikul, Wakhān, Shignān and Roshan [2]. They are likewise the chief property of the nomad Aimaks and Hezāres and of the wandering herdsmen on the borders of the Khāsh desert [3].

No less valuable are sheep and goats to the Afghāns and Kāfirs [4]. On the way to Kabul, Burnes met with thousands of sheep which belonged to the tribe of the Ghilzāis [5]. They were being marched, as the snows had disappeared, into the high valleys of the Hindukush, there to spend the summer.

The fat-tailed sheep of Bokhārā are everywhere known [6]. Their flesh is, as Vámbéry asserts [7], the best he ever tasted in Asia. But it is of course an idle fable to say that the tails of these sheep are sometimes of such weight as to

[1] Roscher, *Nationaloekonomik des Ackerbaus*, § 12, note 3.

[2] Gordon, 'Pamir,' pp. 113, 136; Wood, 'Journey,' pp 212–213, 249. Compare also Middendorff, *Ferghanah*, pp. 289 seq.

[3] Ferrier, *Voyages*, vol. i, p. 364; vol. ii, p. 294, &c.

[4] Masson, 'Narrative,' vol i, p. 212; vol. ii, pp 206, 325

[5] *Bokhārā*, vol. ii, p. 109

[6] Burnes, *Bokhārā*, vol. iii, p. 151; Vámbéry, *Skizzen*, p. 196.

[7] *Reise*, p. 368.

necessitate the animals dragging them along behind them on little wheels [1].

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## THE DOMESTIC COCK.

To what extent poultry were bred by the old Irānian people cannot be determined, since our sources of information are very scanty. They were certainly not unknown, for fowls are spoken of in the Avesta along with other domestic animals [2] Mention is made of the domestic cock [3] particularly, which was highly regarded among the Avesta people He seems to be indigenous to Irān At a comparatively late period he was brought from Western Asia to Europe; for as late as in the Greek comedians he is called the 'Persian bird [4].'

Watchfulness and early rising are reputed a great virtue by the Mazda-worshippers. In it they were aided by the cock which, at early dawn, awakens sleepers by his crowing For this reason he is so highly praised and even held sacred in the Avesta.

The cock is the herald of the *yazata* Srausha, who is active at the early sun-rise [5]. With a loud voice he utters his cry at break of day and chases away the evil spirits of

[1] Schuyler, *Turkistān*, I, 326.

[2] Cf. above, p. 167.

[3] *Parodarsh*, literally 'the foreseer.' He was so called, I think, because he announced and heralded the approach of day by his crowing. The partridge, I suppose, is meant by *kahrka*, for which expressions corresponding with the former meaning are also to be found in the Pāmir dialects (*Tomaschek*, p. 38).

[4] Hehn, *Culturpflanzen*, p. 277 seq.

[5] Vd. XVIII, 15 seq. For 'herald' we have in the original text *sraoshā-vareza* 'maker of obedience.' Commonly 'priest' is understood by this word (Spiegel, *Comm.* vol. i, p. 173). The meaning seems to be that the cock announces to man the time prescribed for the performance of the matutinal ceremonies, as a priest enjoins upon the people the due observance of religious precepts.

night and darkness. The Avesta ascribes to his crowing the following meaning: 'Rise, ye men! praise the genius of piety, curse the demons! If not, Būshyãsta, the evil spirit of sleep, might assault you, who endeavours to pour sleep on all living creatures that are awake at day-break (saying): "Sleep long, O man!"—But this does not become you[1].'

It is said in another place that the cry of the cock is heard even before it dawns in the East[2]. He calls people to light the fire of the hearth. But then his mightiest adversary, the demon of sleep, breaks in and craftily whispers to the awaking: 'Do sleep, ye men! sleep ye, who live in sin, sleep ye who spend your life in sinning!'

With such as did not zealously follow the precepts of the religion of Mazda and especially disliked the commandment of early rising, the cock was certainly no favourite To the sluggard his rousing cry was not seldom very unwelcome. Therefore, they resorted to mockery and contempt in order to discredit, as far as possible, the cock, whose voice sounded sweet and agreeable only to the active and industrious. The Avesta actually mentions two appellations of the cock, one of them expressly stated to be used by evil-speaking men. Of course such defamation of a most useful and honest animal could not but provoke the indignation of the religious and orthodox Irānian and cause him to denounce such infamy.

One of these names is *Kartō-dansu*[3]. Literally, it means 'cutting with knives,' and evidently alludes to the shrill, insupportable cry of the cock. The second name, *Kahrkatās*, cannot easily be explained; perhaps it must be translated

[1] The conclusion offers some perplexities and the text is mutilated. That *hvafsa-dareghō* · *mashyāka* must be the words of Būshyãsta, appears from the passage to be presently brought forward. *Hvafsa* I think to be the imperative of the inchoatine or inceptive *hvafs* from *hvap*; but in this case we might expect the adv. *dareghem*

[2] Yt. XXII, 41–42.

[3] *Karetō-dāsu* from *kareta*, 'knife,' and *dāsu* from the root *dās* = Skr. *damc*.

by 'fowl-biter[1].' It is not impossible that the meaning is obscene.

The latter name, for certain, was already popular in the Arian time. It is also found in the Rig-veda in the form *Kṛika-dāsu*, and is used here also in a contemptuous way to denote the cock. A poet who is fond of sleep gives him this name in a short song in which he curses in a coarse way everything that might trouble his repose: the braying of the ass, the sighing of the wind or the rustling of the forest, and the cry of the cock:

> 'Put to death, O Indra! the ass that brays so piteously!
> Chase away with the bird *Kundṛināchī* the wind far over the forest!
> Kill every one that makes a noise, curse the *Kṛika-dāsu!*'[2]

## The Dog.

Between the manner in which the dog was treated by the Avesta people, and that in which he is now treated by the inhabitants of Persia, there is a great difference. It is well known that he is regarded as an impure animal by Moslems. With the introduction of Muhammedanism into Central and Anterior Asia he has indeed lost all his former dignity and value.

It is narrated by Schuyler that every family of the Sarts has at least *one* dog[3]; but he is by no means treated as a

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[1] *Kahrkatās*, Vd. XVIII, 15. Darmesteter, *Notes sur l'Avesta*, 20. It will scarcely be possible to separate this word from *kahrka*, N.P. *kark* 'fowl' (cf. *kahrkāsa*). Indeed we are tempted to see in *kareta* and *kahrka* nothing but collateral forms of Skr. *karṇa* (formed with suffix *ta* and *ka* instead of *na*), and in *tās* a mutilation of *dās*. In this case the two names might be rendered by 'ear-mangler.'

[2] Rv. I, 29, 5–7. The *dāçu* in Skr. *kṛkadāçu* corresponds, it cannot be denied, more with the *dāsu* of *karetō-dāsu*. But it proves at the same time, that *tās* may be regarded only as a mutilation.

[3] *Turkistān*, I, 130.

favourite, but rather maltreated. He is seldom fed, being generally left to provide for himself. Their dogs are accordingly lean, weakly and half-starved. They are employed for no other purpose than for watching the houses. By day and night they ramble about in the vicinity of the house, giving the alarm whenever a stranger approaches

With the modern Persians the word 'dog' is a by-word of the most insulting kind. As such it is employed in divers contumelious expressions, as for instance: 'Whose dog was your father?' or 'You son of a dog!' It may be remarked that a similar usage is found in the Rig-veda, whereas, on the contrary, such forms of abuse are quite impossible in the Avesta:

> 'He, the god, may choose like a man the song of the pressed Soma; chase away *the avaricious dog*, as the Bhrigus the enemy!'
>
> 'Crush round about *the yelping dogs*, kill the enemies, for you are able to do it, ye Açvins!
> Reward every song of the bard with riches, bless ye both, ye truthful, my hymn!'[1]

There are excellent dogs in Wakhān. It seems also that they are here better treated, because the minds of the people are not yet fully imbued with the spirit of Islāmism According to Wood, they differ essentially from the Indian dogs[2]. They have long ears and a tufted tail, are commonly of a black or reddish-brown colour, in the latter case sometimes spotted. Their shape is lean and more adapted for speed than strength. They are very wild and most watchful, and will attack dogs of double their strength.

In the Avesta the dog is esteemed a faithful companion and friend of man[3]. He is particularly useful in taking care of his master's property, especially by protecting herds and flocks from all damage.

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[1] Rv. IX, 101 13 (otherwise explained by Ludwig, Rv. II, 512); I, 182, 4.

[2] Wood, 'Journey,' p. 246.

[3] *Span* 'dog' = Skr. *çvan*; a monograph of the dog is the Essay of Hovelacque, *Le chien dans l'Avesta, les soins qui lui sont dus, son éloge* in the *Revue de Linguistique*, VIII, p. 187 seq.

The Vendidād represents Ahura Mazda as uttering the following words:

> 'I created the dog in his own clothes and shoes, with keen scent and sharp teeth as the property of man to protect his folds, I created the dog as a guard against enemies. If he is attentive and cares for the flocks, and if he, O Zarathushtra, is watchful with his voice, no thief nor wolf will come unperceived into the villages to carry away booty'[1].

The dog is, therefore, less the servant of man than his friend and house-companion Along with wives and children he forms the ornament of the house and a guarantee of its permanence Numerous dogs are no less desired by the Mazda-worshipper than great herds and a rich harvest[2].

Everywhere the dog appears immediately after man. Of all beasts he stands next to him, almost on a footing of equality. The *yazata* of earth is offended, whenever dead dogs or dead men are deposited in her lap, and the exhumation of such bodies is a work of the greatest merit[3].

The dog is sacred and inviolable It is a great crime to beat, to wound, or to kill him. Whoever caused the death of a dog by his neglect had to undergo a very severe punishment. Every damage suffered by herds or other property, in consequence of injury to the watch-dog, was expiated in the same way as a sin consciously committed[4].

These views of the Avesta completely agree with the narration of Herodotus respecting the Magi, who, he says, kill everything living except man and the dog[5].

The duties of dogs are various. Hence they are divided into several varieties.

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[1] Vd. XIII, 39 seq. This passage offers considerable difficulties. *Draonaṅh* must be compared with Skr. *draviṇas*. I translate *mazu* by 'watchful,' on the basis of tradition, which interprets *māshak* as *zīnāvand*. Beginning from the words *yezi · asti · ash-khrathwa* the original metrical form of the passage may easily be recognized.

[2] Vd. III, 3.

[3] Vd. III, 8, 12; cf. also Vd. III, 36 seq.

[4] Vd. XIII, 10 seq.

[5] Herod., I, 140.

First in rank stands the dog 'that watches the herds [1].' It is his duty to run round the herd on the pasture in order to scare away wolves and thieves. From the fact that he was ranked highest of all we may conclude how much pastoral life was still affected by the Avesta people, and how they regarded herds and flocks as their most valuable property. The sheep-dog of the herdsmen now living in the Pāmir is described as being large, of a pale-yellow colour, with small erect black ears, black muzzle and thin straight tail [2].

Second to him stands the farm-house dog 'that watches the village [3].' He remains near the settlements and has to protect them from the same enemies. For personal safety served the dog 'that goes to the blood [4],' that is to say, who had been taught to keep hold of a man. Finally, we must mention the dog that had learnt to play tricks and, therefore, was less useful, kept only for sport and pastime [5].

All kinds are named together in the passage which treats of the killing of a dog and its consequences:

> 'Whoever kills a dog that watches the herds, or one that watches the village, or one that goes to the blood, or one that has learnt tricks; more dreadfully for us and more hideously will his soul wander into the world to come, than a wolf which roves about in the horrible vast forest [6].'

. . . . . . . . . .

In a strange panegyric, the tenour of which has little

[1] *Spā · yō · pasush-haurvō.* Compare for this and the following statement, Vd. XIII, 17 seq.

[2] *Vide* Tomaschek, *Pāmirdialekte*, p. 29.

[3] *Spā · yō · vish-haurvō.*

[4] *Spā · yō · vōhunazgō* Cf. Spiegel, *Comm.* vol. i, p. 176.

[5] *Spā · yō · drakhtō-hunarō.*

[6] Vd. XIII, 8. Towards the end the passage is metrical and may be restored in the following manner: *Khraosyōtaracha · nō · ahmāt * vayōtaracha · hvō · urva * parāiti (parō-) asnāt · aghvę̄ * yatha · vehrkō · vayō-tūitę̄ * dramnō · barezishtę̄ · razūirę̄.* The translation is difficult; that of Spiegel and de Harlez must be rejected. *Vayōtara* and *vayōtūta* (?) are certainly connected with

interest for us, his qualities are compared to those of a priest, a warrior, a farmer, a slave, a ferocious beast, a bawd and a babe! The first he equals in poverty and contentment, the second in watchfulness, the third in activity and restlessness. He flatters like a slave or a bawd, roves about in the darkness like a thief or wild beast, and his tongue protrudes from his mouth like that of an infant[1]. In short, he has something of the nature of each of them; he combines the characteristics of nearly all beings.

The dog is recommended with earnestness to the care of man by the writers of the Avesta. He who gives him bad or insufficient food must expect the severest punishment. It is not allowed to cast before him bones which have not been bruised, nor any hot food to burn his mouth with[2].

Female dogs big with young must be particularly taken care of. For the lives of many were threatened, if they were hurt by any accident. If such an animal was frightened away, and fell, in consequence, into a cistern or a ditch or a canal, such an offence could by no means be expiated[3].

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Skr. *bhī, bhaya.* Instead of *dramnē* I conjecture *dramnō* (from root *drā* 'to run'). The former originated from its connection with *vayō-tūtē*—A division of dogs still more detailed will be found in Vd. V, 29. In this passage *spā-jazhu*sh, *aiwizhu*sh and *vīzhu*sh are obscure. With *sukuruna* compare *skon* 'whelp' in Wakhi (Tomaschek, *Pamirdialekte*, p 29); *spā-taurunō* is perhaps the greyhound, an excellent breed of which is found in Persia.

[1] Hence the strange epithet of *hizu-drājağh.* In just the same way the dog is called *dīrgha-jihvya* (Rv. VI, 101, 1). Perhaps the word may have, in the Avesta, at least a metaphoric signification, I suppose, 'talkative,' to which N.P. *zabān-dirāz* might be compared.

[2] Vd. XIII, 20 seq.; XV, 3.

[3] Vd. XV, 5. The word used here for bitch is *gadhwa.* It certainly cannot mean 'cat.' In the preceding context dogs only are spoken of; nor is it probable that the cat was so early known. See Hehn, *Culturpflanzen*, p. 531. Now indeed cats are very frequent in Turkistān and fine specimens are seen there. Schuyler, *Turkistān*, vol. i, p. 130.

What a contrast between these precepts and the way in which dogs are now treated in Central Asia!

A peculiar purifying power was attributed to the dog. Among other evidences this appears from the ceremony of the *Sagdid*, although the latter has also an idealistic background. Ways by which dead bodies had been carried, were purified by leading over them a dog with certain marks. At sight of him fled away the *Druj Nasush*[1] which had taken possession of the way[2].

. . . . . . . . . .

It is known that dogs which have lapsed into a kind of savage state are a plague to several countries of the Orient It seems to have been so already in Old Irān At least there occurred, according to the Avesta, instances of men being killed by dogs[3]. It was, we may suppose, particularly half-savage dogs which trailed forth carcasses and, like foxes and wolves, devoured the corpses exposed on the Dakhmas[4].

## § 19. *Agriculture.*

THE combination of the terms 'cattle-breeder' and 'husbandman' is in the Avesta the constant and official denomination of the peasantry[5]. Thus by the very idiom itself the double nature of husbandry is indicated.

In a like manner the words 'fields' and 'herds' are

[1] *Vide* Introduction, p. xxxix. [2] Cf. *supra*, pp. 76, 81.

[3] Vd. VII, 4. [4] Vd. V, 3; VI, 46.

[5] *Vāstrya-fshuyās.* The former word is derived from *vāstra* 'pasture,' and represents the farmer as the owner of herds and flocks. But *fshuyās* is, in my opinion, a derivative of the root *fshu*, which must be connected with Skr. *psā* 'food' (cf. also *psur*). By food we must understand corn. It is also called *hvaretha* in the Avesta. Cf. Spiegel, *E. A.* vol. iii, p. 654 seq. In Ys. XXIX, 6 the words *fshuyañtaęcha-vāstryāicha* 'husbandman and owner of cattle' are even used separately.

frequently employed together[1]. Yima, the herdsman of the people, prays to Druvāspa: 'Grant me that I may bestow *fields* and *herds* on the creatures of Mazda, that I may bestow immortality on the creatures of Mazda!' Then he asks of Anāhita the boon, that he may wrest from the demons riches and bliss, fields and herds, abundance and power[2].

The nature of the soil in the country of the Avesta people is on the whole more favourable to cattle-breeding than to agriculture. There is abundance of pasture, but the soil adapted to tillage is rather scanty.

By glancing at present conditions we shall be better able to judge of the husbandry of this people in antiquity.

The cultivable and cultivated land in Central Asia is of two kinds. It lies either on the slopes of the mountains or immediately on the banks of rivers. In the former it derives the necessary moisture from springs and atmospherical deposits, in the latter from artificial irrigation.

Thus the rude and barren tracks of the higher mountains are, on the whole, excluded from agriculture. It is only in the wider and more open valleys, as in those of the Panja, the Kokcha, the Herīrūd and other rivers that corn can be produced in considerable quantities, as far as climate and temperature will allow. In the glen-like transverse valleys only isolated parcels of the soil can be brought under tillage. The pastures alone are as a rule of real value for the husbandry of the people in Central Asia.

Low-lying plains and plateaus are for the most part no less unfit for the cultivation of corn. Even along the banks of rivers it is only possible when the construction of water-channels is not rendered impracticable by the configuration of the land. Wherever the surface of the river lies beneath the bottom of the valley, wherever the bank rises steeply, its waters are often quite useless.

Schuyler says with respect to the Russian dominions[3]:

[1] *Fshaonī · vāthwa.* The former is, indeed, connected with *fshuyat* and means 'corn, cornfield.'

[2] Yt. IX, 9; V, 26. Cf. Yt. XIX, 32.

[3] *Turkistān*, vol. i, p. 284.

'A map of Central Asia, on which all the arable lands were carefully marked, would be at once instructive and curious, so narrow would be the green strips along the rivers and at the foot of the mountains.' According to his calculations, in the district of Zerafshān only about one-sixth part of the soil is cultivable. In adding the districts of Khōjend and Kurama this proportion will be still less favourable, since in those provinces there are vast deserts. In the latter case there remain only about two twenty-fifth parts of useful ground, in Central Asia altogether no more than one-sixtieth part.

As to the districts in the South of the Amu I have no statistical computation like that of Schuyler for Turkistān. But in reading the accounts of the journeys of Wood, Ferrier, Grodekoff and others, we may probably conjecture that the nature of the soil must be very similar there

The northern slopes of the Hindūkush apparently contain in their valleys a rather considerable extent of cultivable land. Even far from the banks of rivers good pasture-land is found; but, for want of moisture, the ground is not fit for raising large crops of corn. This is expressly stated by Wood with respect to the district lying between Kurum and Ābi-Kunduz[1]. The plateau between Kurum and Siripūl, which has been traversed by Ferrier, appears to be of a similar nature[2].

If soil of natural productiveness were found in abundance, the water of the rivers would not be utilized as was actually the case.

In the upper and middle course of a river the ground does not always allow the turning-off of the waters into channels. And yet a great number of such channels were passed by Ferrier, as he approached the Dehās on his way from Kurum[3]. The river Sīripūl, also, has such low flat

[1] Wood, 'Journey,' pp. 135–136. The plain between the streams that water Kunduz and Kurum has an undulating surface, and, though unfit for agriculture, affords excellent pasturage.

[2] Ferrier, *Voyages*, I, pp. 417–418.

[3] Ibid. p. 419.

banks near this town, though it is situated in the mountains, that its water can be made use of for irrigation in spring[1].

Naturally, artificial irrigation is not employed to any great degree before the rivers enter level land. Consequently, some of the most considerable settlements are situated on the very verge of the desert. The flat districts in the neighbourhood of Balkh are traversed by numerous channels, which distribute the water over the whole plain on which lie the ruins of ancient Bactria. This, in old times, caused its great fertility, and is at present the cause of the marshy state of its soil, where cultivation does not flourish[2].

But the water of the river is absorbed by this manner of irrigation to such a degree that it disappears in the sands of the steppes without reaching the Oxus. Yet, even in the North-East of Balkh, there are ruins of considerable extent in the midst of the desert. They are called Siyāh-gird[3]. They certainly afford proof that in earlier times the quantity of water flowing from the mountains was by far greater, or at least that cultivation was far more efficient than now-a-days.

What has been said of Balkh is no less true with regard to Kunduz and Khulm, Shibārjān and Andkhūi, and particularly with regard to the oasis of Merv[4].

The situation of the Herīrūd is apparently more favourable. Its valley is broad and open, and arable land is found in greater extent even near the middle course of the stream. The district of Haraiva, therefore, was doubtless, in early times, already an important centre of cultivation. The same may be said with respect to the tracts situated to the West on the Keshef, the Atrek and Gurgān, which led the people up into the more fertile fields of Media.

A large tract of fertile ground is also found about the lake of Hāmūn, but the soil is not seldom marshy. It was

[1] Cf. p. 70 of *Ostīrānische Kultur.*

[2] Grodekoff, 'Ride,' p. 80; Ferrier, 'Voyages,' vol. i, pp. 389–391; Burnes, 'Bokhārā,' vol. ii, p. 207; Elphinstone, 'Kabul,' vol. ii, p. 213.

[3] Grodekoff, 'Ride,' pp. 13–14.

[4] Comp. pp. 60, 62, 69, 70, 71 of *OKA.*

without doubt necessary to drain it in many places, before tilling and sowing were possible. East of the lake of Hāmūn waterless deserts extend as far as the mountains, only a few strips affording suitable pastures to nomad tribes, at least in winter. Arable land is found only in narrow strips along the rivers Farārūd, Khāshrūd, and especially the Hilmend. But cultivation is here rendered possible only by artificial irrigation.

In the mountainous regions of the Aimāks and Hezāres there is abundance of natural pasture. It may be regarded as certain that agriculture is possible in some places, but in comparison with cattle-breeding it will doubtless remain unimportant.

I shall now pass over to the province South-West of Cābul, between the inner Suleimān range and the Hilmend. It has the general character of a rather sterile plateau traversed by ranges of mountains. There are sufficient pastures; but fields and gardens are confined, for the most part, to the banks of rivers, namely the Arghandāb, the Tarnak, and the Arghesān. Here also the ground everywhere requires an artificial supply of water in order to repay cultivation.

The mountains of Pishīn are rocky, cold, devoid of vegetation. Even the plateau of Tōba, praised for its beauty, consists almost exclusively of pastures. Corn is grown in small tracts, where the ground can be watered. The Shōrawak too owes its productiveness exclusively to artificial irrigation [1].

We know little about the nature of the soil of the upper Kurum and Gōmal, where pasture-land is certainly abundant; however, arable land cannot be wanting since there is no lack of irrigation. The valley of the Cābulrūd is no less adapted for extensive cultivation. But in the mountains of Kōhistān, Kāfiristān and Chitrāl, the land available for tillage is, for the most part, restricted to the wider valleys and the more gentle slopes. Pasture-land is here also very common. The rugged and rocky parts of the highest mountains are absolutely useless for cultivation.

[1] Comp. pp. 110, 112 of *OKA*.

With such conditions of soil, husbandry must naturally increase and flourish. It is a matter of course that every spot of land, even the smallest, is profited by, if it can be cultivated. As the sterility of the soil is caused by the deficiency of moisture, artificial irrigation is especially employed in a most rational way, and advantage is taken of the water of rivers, lakes and springs as far as possible.

Indeed the irrigation of the soil is carried out with admirable care throughout Turkistān, Afghānistān and Persia.

The Persians evince great ability and skill in their system of irrigation. And yet it is followed by people who have no technical knowledge at all, and whose appliances must be called to some extent defective. We cannot but admire whatever the Persians accomplish in finding out springs, in digging subterranean channels, in dividing and diverting rivers. Hundreds of villages have been created by turning the course of rivers or by separating *one* river into several branches[1].

The beauty of the aqueducts in the environs of Herāt is praised by many a traveller[2]. The system of irrigation practised in Afghān Turkistān, especially in the neighbourhood of Balkh, Andkhūi and Shibargān, has been referred to by me on several occasions. Nor is it less certain that the oasis of Khiva owes its fertility solely to the channels cut from the Oxus.

Nowhere, I think, is the art of watering fields more perfect, nowhere is every drop of water turned to better account than in the valley of the Zerafshān. We are perfectly right in stating that here population can only increase if the supply of water increases.

According to Radloff[3], it might be difficult, even for scientifically trained engineers, to make anything more skilfully than has been done by the people that dwell on the banks of the Zerafshān. The picturesqueness of the

[1] Polak, *Persien*, vol. ii, pp. 116, 119; cf. Ritter, *Asien*, VIII, p. 448; Roscher, *Nationalokonomik*, § 36, note 6.

[2] *Vide* pp. 73–74 of *OKA*.

[3] *Zeitschrift der Gesellschaft für Erdkunde*, vol. vi, p. 407 seq. Comp. Khanikoff, *Bokhārā*, p. 46.

neighbourhood of Samarkand depends entirely on artificial irrigation. Without such a supply of water the valley would be sterile and barren. But now the banks of the river are crowned by blossoming gardens and groves of fruit-bearing trees, by waving fields and smiling meadows, wherein feed numerous herds. And not far from here lies the most dreary desert of the globe!

The system of irrigation adopted by the inhabitants of the district of Zerafshān is described at length by Schuyler[1].

Between Penjkend and the lake of Dengiz into which the Zerafshān flows, 85 principal channels are numbered Their whole length amounts to 2500 kilometres. The numerous branches and ditches, which divide from the channels and distribute the water over fields and gardens, are not included in this reckoning.

The first great channel, called Bulungur, branches off near Penjkend from the right bank. It waters the tracts to the North of the river and is one of the oldest in the valley of the Zerafshān.

Further down, on the left side, begins the channel Dargam[2]. This supplies Samarkand and the territory on the left side of the Zerafshān with the necessary moisture.

At the foot of the hill Chupān-ata, not far from Samarkand, the river divides into two different streams. The Northern is called Ak-daryā, 'white stream;' and the Southern, Karā-daryā, 'black stream.' They enclose an island of considerable fertility. Its length is 113 kilometres, its greatest breadth 14 kilometres. Above Katta-kurgān the Karā-daryā sends off the channel Nari-pāi, which returns after a course of 80 kilometres into the Zerafshān near Kermin. The whole Eastern part of Bokhārā depends on the Karā-daryā and Nari-pāi for its water-supply.

The town of Bokhārā and the province in the North of it are watered by the Sheheri-rūd and other channels, which branch off from the Zerafshān below Kermin. Almost all

[1] Schuyler, *Turkistān*, vol. i, p. 286 seq.

[2] *Vide* p. 33 of *OKA*.

the rest of the water of this river is distributed over the country by ditches and channels; only a very small portion reaches the lake of Dengiz.

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At the first colonization of the country the Arians, indeed, commenced with cultivating tracts that were naturally productive But very soon misfortunes, attended with great danger, began to be felt. The rainfall in Turkistān and Eastern Irān is extremely unequal, the success of the harvest is, therefore, very uncertain [1]. Bad harvests and times of pressing want and distress must have been experienced.

In the early times, therefore, the project was planned of employing the water of rivers for the irrigation of the fields. The colonists settled on the banks of a river and extended their fields as far as artificial irrigation was possible

The Avesta people had already no inconsiderable technical skill for irrigation. In the Gāthās, it is true, this subject is not spoken of. We shall see that this is to be accounted for not only by the scantiness of the texts, but

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[1] Schuyler, *Turkistān*, vol. i, p. 292: 'Experience shows, too, that the harvests on these (rain) lands are exceedingly variable Thus, for example, in 1862, the extensive rain-lands to the south of Katta-kurgān, called Chul, produced 1,106,000 bushels of wheat, in 1868: 155,620; in 1870: 486; and in 1871: 12,430. . . . The great famine of 1870 is still remembered. From 1810 to 1811 there was no winter, and no rain fell in the spring, wherefore the harvest in the rain-lands failed entirely, and there was such a famine that men sold their children, their sisters and mothers, and either killed the old people or left them to starve. In 1835 there was another famine from the same causes, but less disastrous in its consequences, as there had been a remarkably good harvest in the preceding year. In the winter of 1869–70 there was no snow and very little rain in the following spring, so that the wheat on the rain-lands had no sooner sprouted than it dried up.' These facts are taken from an essay written by Grebenkin on the 'Causes of the Bad Harvests in Bokhārā,' published in the *Turkistān Gazette*, 1872, Nos. 17 and 18.

that it is also founded on the economical state of the first period of Zoroastrian civilization.

In the later Avesta we see that agriculture was highly developed. All the means are already known and employed by which nature is assisted and its deficiencies relieved in Central Asia even in our days [1].

Both the draining of morasses and the irrigation of arid soil are praised as highly meritorious [2]. Such draining was indispensable in some regions, as for instance on the Hāmūn; while irrigation was almost necessary in all parts of the country. The religion of Mazda invites its adherents to ceaseless activity in agriculture no less than in other pursuits. It bids them fight against sterility and barrenness, and create instead of them affluence and culture.

Only the cultivated ground is the property of Mazda. Regions devoid of cultivation are haunted by evil spirits. Wherever, therefore, a follower of the Avesta religion settles, it will be his first duty to render the soil productive. It is a triumph of the good cause whenever a portion of arable ground is wrung from the death-like desert. In the Vendidād the genius of the earth is said to rejoice at the soil being tilled and corn produced, and to mourn at its remaining barren and sterile. The earth is like a woman, who misses her vocation when she grows old childless, but who is proud in happiness and beauty when healthy sons owe their lives to her [3].

This view will explain why in the Avesta belief and unbelief are so often brought in immediate connection with the vegetable life of nature.

At the birth of Zarathushtra the waters and plants increase. On the contrary, a sinner who has defiled

[1] Terms of agriculture are: *aiwi-varez* 'to work the soil' (N.P. *barzīdan*, *barzīgār*, *barzīgārī*); *kāraj* 'to beget, to produce (fruit)'; *yaokar*sh*ti* (from *yava*+*karshti*, from root *karesh*=Skr. *kṛsh*, cf. *kṛ*sh*ti*, *charshaṇi* 'cultivation of corn').

[2] Vd. III, 4-5.

[3] This idea is chiefly made use of in the third chapter of the Vendidād, and forms the key-note of the whole passage. Cf. *ZddmG.* vol. xxxiv, p. 421 note.

himself by touching a dead body, will cause the pastures to be parched by heat or herds and flocks to be endangered by enormous masses of snow in winter[1].

A misbeliever, an *Ashemaugha*, takes away all fertility from the country he dwells in. Only after he has suffered merited death is it that prosperity and affluence, bliss and plenty, will return to it[2].

The prostitute, who mingles the seed of the pious and impious, is said to dry up by her looks a third part of the running waters, and to stunt a third part of the beautiful gold-coloured plants. The attacks of evil spirits are directed peculiarly against the fertility of the earth. The good spirits endeavour to keep off these assaults:

> 'When the Evil Spirit sought to overwhelm the creations of the Good and Holy Spirit, there intervened, hostile to him, Vohu-manō and the Fire. They both overthrew the enmity of the evil, wicked Spirit, that he might never check the course of waters, nor prevent the growth of plants. At once the blissful waters of the high Creator, of the powerful Ahura Mazda, began to flow and His plants began to sprout[3].'

The practical side of the Zoroastrian religion was, of course, of the greatest importance for civilization. What happy influence it exercised in Persia has been shown in an excellent manner by Ritter[4]. By the cultivation of the ground, the construction of fountains and the planting of trees the rigour of the Irānian soil and climate were gradually and imperceptibly mitigated.

It is certainly not unknown that the last followers of the Zoroastrian religion on Persian ground, the Guebers in Yezd and Kirmān, chiefly attended to horticulture. It was not by the severity of external circumstances alone that they were compelled to do so[5]. They were in no less

[1] Yt. XIII, 93; Vd. VII, 26–27. [2] Vd. IX, 53–57.

[3] Yt. XIII, 77–78. Cf. Geldner, *Metrik*, § 81.

[4] *Asien*, vol. viii, p. 275.

[5] Khanikoff, *Mémoire*, p. 203: 'Empêchés par la concurrance

degree influenced by their religious precepts and their habitual esteem for agricultural pursuits.

Artificial irrigation is, according to the Avesta, an indispensable requisite in agriculture[1]. In the district of Zerafshān there is a custom of dividing the field into squares in growing lucern and grain which demand an equal distribution of water They are separated by small ridges a few inches high. When they are filled with water, the opening from the canal is closed and the water is left to soak into the soil[2].

Probably, in old times as at present, the main channel was first dug. From it there branched off, if wanted, secondary channels and ditches which distributed the water over the fields It is characteristic of the regard for public utility in the Avesta people, that in the Vendidād the construction of water-channels is enjoined as compensation for trespasses[3].

On fields too distant from the river wells were dug in search of springs[4]. The water was then drawn up, we must suppose, by means of suitable appliances.

In the construction of wells the modern Persians show

des musulmans de prendre une part active dans le commerce et dans l'industrie manufacturière, les Guèbres se livrent presque exclusivement au jardinage.'

[1] *Nāiat · āpem · hiñchaiti · avi · yavō-charānem*, Vd. V, 5; *mācha · paschaeta · Mazdayasna · tām · zām · kārayen, mā · āpō · harezayen*, Vd. VI, 2.

[2] Schuyler, *Turkistān*, vol. i, p. 289.

[3] Vd. XIV, 12; V, 5. The ditches made for irrigation are called *vaidhi* or *vāidhi*. In the Pāmir dialects (*Tomaschek*, p. 24) is found *wādh, wiédh* with the same signification. A greater channel is called *urudh*, Vd. XIII, 38. The order of the expressions, *maegha, chāiti, vaema, urudh, āp-nāvya*, is to be observed. The enumeration is made apparently from the smallest to the larger. Justi translates 'river,' but this is probably denoted by the last expression. I would refer also to Vsp. XVI, 3: *shōithrya · apascha · zemascha · urvarāoscha*, 'the waters, fields and herbs appertaining to a settlement.'

[4] *Chāiti* or *chāt*=N.P. *chāh* '*puteus, fovea*.' Vd. XIII, 38; VI, 33.

special ability. They combine them by horizontal stream-works, so as to form a whole net-work of subterranean channels. The water is drawn up in the following manner: the bucket, fastened to a rope, is sunk into the well; the rope runs round a beam, oxen yoked to its opposite end draw up the bucket when filled. In order to lighten the work the team is commonly driven down an inclined plane[1].

In regions where water was particularly scarce, cisterns seem to have been constructed[2]. The rain-water gathered there appears to have served for men and herds. It was scarcely sufficient for irrigating the fields.

The Avesta distinguishes three stages in agricultural pursuits: *watering*, *ploughing up*, and *ploughing down*[3]. The ploughing up was immediately followed by the sowing of corn. Then the seed was covered with earth. Of the form of the plough and of the harrow nothing certain can be stated. At present agricultural implements are very simple and primitive in Turkistān. Hence we may suppose that they were no less so in ancient days.

According to the statements of the Avesta, the irrigation of the soil must have preceded the work of the plough. It was considered a preliminary condition of tilling and sowing. But it was not thought sufficient to water the fields only once. It was repeated two or three times[4]. In agreement with this is the actual custom of the peasantry in the environs of Samarkand in growing wheat.

'Winter-wheat and barley are sown about the middle of September, and worked in with a rude harrow. Winter-

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[1] Polak, *Persien*, vol. i, p. 120.

[2] Such cisterns are probably meant (Vd. XV, 39) by *avakana* (from root *kan* 'to dig').

[3] Vd. VI, 6: *hikhti*, *karshti* (from root *karesh* 'to draw furrows'), *parakañti*.

[4] Vd. XIV, 13: 'Arable and productive land (*zãm · karshyãm · raodhyãm*) shall be given to pious men in good piety for the expiation of the soul. Creator! of what kind must the land be? Such (a land) *as is twice watered*.' Vd. V, 5; *ana · tã · vaidhīm ayão, ana-bitīm, ana · thritīm*; *pascha · tūirīm*.

wheat is irrigated two or three times, barley only once, and the harvest ripens about the end of May[1].'

We do not learn anything further of the tasks and labours of the farmer until the harvest-time. Nor can it be stated, as I have already remarked[2], what kind of grain was cultivated. At present, wheat is general in Turkistān. In the district of Zerafshān one-fourth part of the watered land is sown with wheat, about one-fifteenth only with barley[3]. The agricultural system followed by the Avesta people especially resembles that which is at present employed with respect to wheat. Yet I dare not hence draw any natural conclusion with regard to the ancient practice.

The time for gathering the harvest was, of course, very different according to climate and temperature, and even according to the season of sowing in different provinces. By the beginning of September the crop was everywhere brought home, even in the coldest districts. At this time, therefore, the harvest-feast was celebrated[4]

When the corn was cut, it was probably trodden out by horses and oxen driven over the sheaves spread on the ground. This method is still generally practised. Whatever was not immediately consumed was preserved in *barns*. The separation of the grain from the chaff was performed by *winnowing* or *fanning*. In the *mill*, the construction of which was certainly most primitive, the corn was ground and so meal was made[5].

1 Schuyler, *Turkistān*, vol. i, p. 290.

2 Comp. pp. 151–152 of *OKA*.

3 Schuyler, *Turkistān*, vol. i, p. 291.

4 *Paitish-hahya*. *Vide* p. 146 of *OKA*. Hence, therefore, we must not conclude that the climate was exceptionally rigorous. How is it possible to lay down a universally valid law for territories of such diametrically opposite character, as Balkh and Kabul, Seistān and Ghazna, the districts of Panja and Zerafschān? The harvest certainly took place one or two months later in the mountain valleys than in the hot plains.

5 *Yavan* 'barn' (Vd. XVII, 3); *sudhush* 'winnowing-fan' (from rt. *sudh* = Skr. *çudh* 'to cleanse'), Vd. III, 32; *pishtra* 'mill' (from rt. *pish* 'to grind'); *gunda* 'meal.' Schuyler, *Turkistān*, vol. i,

Not only corn, but also grass and fruit-trees were objects of cultivation with the Avesta people:

> 'Creator of this material world, Thou Holy One! Where, thirdly, is the Earth most gladdened?' Ahura Mazda answered: Wherever grain is mostly produced, O son of Spitama, Zarathushtra, and grass and fruit-bearing trees; wherever arid land is changed into watered, and marshy into dry land[1].'

We know that in Old-Irān stall-feeding was necessary during winter. This required the storing of hay in spite of abundant pastures. According to the passage cited above it will scarcely be contested that *grass was grown*[2]. But it was certainly restricted as far as possible on account of the small extent of productive land. But a portion of the winter fodder might have been also obtained from pastures.

It is a matter of importance that *the Avesta people also cultivated trees*. This circumstance proves that they were a fully-settled people. He who cultivates grain, takes care of his immediate wants, but he who rears trees, thinks less of his own advantage than of that of his children and grandchildren who shall one day enjoy the fruits of his labour. He supposes that his progeny will dwell on the same land, will plough the same field Confiding in their love and reverence for himself he will leave them his land in the best possible condition.

I have already spoken about the abundance of fruit in Turkistān and Eastern Irān[3]. Persia and Afghanistān, which are more favourably situated, are famous for their splendid gardens.

In his description of the inhabitants of Zerafshān in connection with the subject of horticulture, Schuyler says:

p. 290: 'The grain, instead of being thrashed, is trodden out by oxen and horses, and then cleaned by being tossed in the air.'

[1] Vd. III, 4.

[2] Also in Vd. XV, 41–42 the question seems to refer to artificially laid-out meadows (*yō · aṭ̣tem · vāstrem · uzdasta · vāstrīsh*). It is true that Geldner translates 'hurdle.'

[3] *Vide* p. 151 of *OKA*.

'The gardens are the glory of all this land. The long rows of poplars and elm-trees, the vineyards, the dark foliage of the pomegranate over the walls, transport one at once to the plains of Lombardy or of Southern France. In the early spring the outskirts of the city and indeed the whole valley are one mass of white and pink with the bloom of almond and peach, of cherry and apple, of apricot and plum trees, which perfume the air for miles around. Nowhere are fruits more abundant, and of some varieties it can be said that nowhere are they better[1].'

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Little can be stated with certainty as to the system of managing farms followed by the Avesta people. It may have varied in different provinces.

A system of fields having permanent pasturage is best adapted to the conditions of the soil. It is characteristic of this system that the ground is divided into two principal portions, of which one is employed for growing corn, the other as permanent pasture[2]. The former lies nearer to the centre, or the settlement, in order to lessen the work in the fields. In Irān it was limited to the banks of rivers, or slopes naturally irrigated.

Manuring was unknown. Had it ever been practised, it would have been mentioned among the preparatory stages of agriculture not less than irrigation. Nor do we know whether several species of grain were cultivated or whether the rotation of crops was understood. It was necessary, therefore, to let the soil lie fallow at certain periods. It was also not impossible to turn it into grass-land, since the cultivation of meadows was at least not quite unknown.

Finally, I again refer here to the state of husbandry in the district of Zerafshān, as known to us and as described by Schuyler[3]:

'Farmers possessing only four or five acres endeavour by careful cultivation to get as much out of their land as

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[1] *Turkistān*, vol. i, p. 296.

[2] Roscher, *Nationalokonomik*, § 25.

[3] *Turkistān*, vol. i, pp. 289–290.

possible, without allowing it to lie fallow too long In general the larger farmers pursue a modification of the three-field system. The field, after lying fallow for a year, is sown with winter-wheat or barley. The next year, after this crop is reaped, the land is again ploughed up and sown for the second harvest with millet, sesame, lentils, carrots or poppies.'

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## § 20. *Manufactures.*

EVERY manufacture begins in the family. Originally, it is exclusively a domestic industry. Wherever it has already begun to become a profession, it is not the exclusive occupation. Farming is carried on at the same time as a subsidiary employment, as is not seldom the case in our villages.

Not before considerable numbers crowd together in one place, or before a lively commercial intercourse allowing the constant exchange of manufactured articles in return for natural productions, arises, will industry make any great progress. This progress, therefore, coincides with the gradual development of villages into towns Then, by reason of the increasing demand, the manufacturer is able to support himself and his family by his industry. He finds it no longer profitable to work in the fields. All his energy is devoted to his craft; increasing custom sharpens his ingenuity, and thus industry thrives not merely in extent but also in excellence.

With the Avesta people it is true that manufactures did not develope in such a normal way. And yet the following sketch may serve as a standard whereby to judge the state of industry in Old-Irān at the period described in the Avesta.

The articles of manufacture in use among the Avesta people were many and various, in fact, too varied to allow us to think of them as merely the productions of domestic industry in the full sense of the word. Thus we are

compelled to assume that there was a distinct class of handicraftsmen.

With these brief observations I proceed to enter more closely into this question

Special skill seems to have been shewn in the working of metals. The manufacture of instruments of gold and brass or bronze was the most important branch of this industry; but silver, copper and lead too seem to have been worked[1]. We must not forget that the Avesta texts are too scanty to furnish an idea of the instruments which they made use of, or of their mode of working and technical knowledge.

*Gold* was the best known and most precious metal. No less on account of its brilliancy and splendour, than on account of the little difficulty which it offers to the workman, it was employed first of all metals in different parts of the world.

In Old-Irān jewellery was chiefly made of gold. The Avesta[2] speaks of golden fillets, ear-rings and necklaces. Gold cups or bowls seem to have been used on the occasions of the Hauma consecration[3]. Gold was also employed for the embellishment of arms, particularly the hilts of daggers and swords The dagger, which the legendary king Yima wore as a badge of his sovereign power, is styled 'decorated with gold[4].' Finally, it must be mentioned that gold embroidery on garments, coverings and carpets was not quite unknown[5].

[1] *Vide* pp. 147–148 of *OKA*. The workshop (?) of a worker in metals is called *pisra*. The particular class is denoted by the compounds: *zaranyō-saẹpa*, *erezatō-saẹpa*, &c *Pisra* may be connected with Skr. *piç* 'to adorn, to decorate, to work skilfully'; *saepa* must be derived from rt. *sip*, which has been preserved in N.P. *siftan* 'to harden.' For the whole statement compare Vd. VIII, 87 seq., where you will find a list of manufactures in which fire is used.

[2] *Zaranyō-pusa* 'with golden fillets' (Yt XV, 57; XIX, 41); *zaranyō-mina* 'with a golden necklace' (Yt. XV, 57). Cf. Yt. V, 127 and p. 227 of *OKA*.

[3] *Tashta-zaranaẹni*. Ys. X, 17.

[4] *Ashtra-zaranyō-paẹsa*. Vd. II, 7. Cf. Skr. *hiranya-peças*.

[5] See pp. 223, 225, 227 of *OKA*.

Gold is principally mentioned wherever divine beings or things belonging to them are spoken of.

The chariot and the chariot-wheels of the *wind-yazata* Vayu and of Mithra are made of gold. The former wears a girdle, a helmet, and arms of gold; the latter is clad in a gold coat-of-mail[1]. The very hoofs of the horses of Mithra and Srausha are shod with gold or silver[2].

It is hardly necessary to say that these words are merely metaphorical. Certainly no one will conclude from such descriptions that helmets or mail-coats, nay, even chariots and wheels and horse-shoes, were made of gold! Yet by these figures of speech it is proved beyond doubt that these precious metals were worked to no little extent. We see also that gold was considered a symbol of affluence and splendour and therefore reckoned among the possessions of divine beings.

Besides vessels of gold there were others of silver, brass and copper, and likewise of stone, clay and wood[3]. Those of brass or lead were of least value. The most common things only, used in every-day life, were made of these materials. It must be remarked that vessels of lead were apt to become very dangerous to health[4].

*Silver* was considered inferior only to gold. But the former was worked far less than the latter. The cup in which the Hauma is purified is made either of gold or silver. Mithra wears on his head a helmet of silver[5].

Arms and weapons are chiefly made of brass or bronze, e.g., helmets and coats-of-mail, arrow-heads and metal-heads of clubs, as well as the blades of swords and daggers[6].

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1 Yt. XV, 57; X, 112, 124, 136.

2 Yt. X, 125; Ys. LVII, 27.

3 Vd. VII, 74 seq. treats of the cleansing of such vessels. Cf. *hāvana - ayaghaena* (Ys. XXII, 2).

4 *Ayaghaenem - vā - srum - vā - nitema - khshathra - vairya.* Vd. XVI, 6.

5 Ys. X, 17; Yt. X, 112.

6 An iron-foundry is called *fra-hich* (Yt. X, 96). Compare Skr. *sam-sich*, Athrawa-veda, XI, 8, 13 (B.R. *sub voce*).

In the Avesta, therefore, the word 'brass' is metaphorically employed for arms.

Clubs were also covered with plates and knobs of *copper* to increase their size and weight [1].

I come now to pottery.

Earthen vessels have already been mentioned above. They were usually baked in kilns [2] specially constructed for the purpose. The art of making and burning tiles was also well known. But glass, as I think was not yet made. The belief that the old Irānians manufactured glass would lead to important conclusions in the history of civilization. But it rests only on an incorrect interpretation of the text [3].

I would, likewise, ascribe the use of coal as fuel to the age of the Avesta [4]. The melting of metals required a fire of intense heat. This want may first have led to the use of coal. The material was less deficient in old times, we may suppose, than now-a-days.

The art of *weaving*, though very old and known already in the Indo-Germanic period, is mentioned quite casually in the Avesta [5]. With it is mentioned the art of working the skins of beasts into garments. Since Anāhita especially is represented as clad in skins, I conjecture that the robes of the nobility in particular were trimmed with fur. The

[1] Hence *chakushanãm-haosafnaenanãm*, Yt. X, 130.

[2] *Tanūra*, N.P. *tanūr*, seems to denote the potter's kiln.

[3] Vd. VIII, 84–85 says *khumbat · hacha · zemaini-pachikāt* and *khumbat · hacha · yāmō-pachikāt*. The first I translate 'from a potter's kiln, where clay is burned,' the latter 'from a potter's kiln, where vessels are burned.' The former term refers to the making of tiles, the latter to pottery in its proper sense. It cannot be thought strange that the making of the two articles was regarded as a *single* manufacture, and both are therefore called *khumba*. Of course *yāma* is connected with N.P. *jām* '*poculum*.'

[4] I infer this from Vd. VIII, 95, where I identify the word *skairya* with N.P. *sakār, sagār* 'coal.' Thus also Geldner.

[5] *Vap* 'to weave.' Cf. *vastra-ubdaęna* 'woven garments.' More difficult of interpretation is *izaena · vastra*, which can scarcely be separated from * *iza*, Skr. *aja, ajā* 'goat.' It does not, therefore, signify garments of skins, but those made from the hair of goats. Cf. p. 224, note 5 of *OKA*.

passage referred to proves at the same time that they knew well the seasons in which it was either profitable or the reverse to hunt beasts for their fur.

The building of carriages and the making of harness attained a high degree of perfection among the old Irānians and the old Indians. But it is to be regretted that many of the terms in question are obscure in the Avesta.

A distinction was made, I think, between war-chariots and baggage-wagons[1]. The former bore a driver and a combatant, the latter served for the carriage of goods during peace.

As a rule there were two horses to each chariot. They stood on the right and left sides of the pole, and their halters were fastened to it by means of iron hooks[2]. Sometimes a carriage-and-four was used[3]. Rich and noble gentlemen chiefly indulged in this luxury. The chariots of the *yazatas*, therefore, are especially described as drawn by four horses.

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## § 21. *Medicine and Commerce.*

THE art of healing appears in the Avesta as a profession of a higher order. It plays no unimportant part in our texts. It had apparently already attained a certain degree of perfection; and, as I am inclined to believe, the priests all devoted themselves to this profession[4].

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[1] Av. *ratha* and *vāsha*. A horse completely harnessed is called *aspa-yukhta*.

[2] *Ākhna* and *aiwi-dāna* (= Skr. *abhidhānī*; cf also Tomaschek, *Pāmirdialekte*, p. 73). Also in Yt. X, 125 some parts of the harness are enumerated, e. g. *hām-isa, Sima*; but I cannot make out their meaning.

[3] *Vāsha - chathru-yukhta*, Vd. VII, 41.

[4] *Baēshaza*, 'art of healing,' 'medicine,' and 'physician.' The last is also called *thamanaghvat*. Again medicine is *baęshazya*. Cf. Skr. *bhishaj* and *bheshaja*. The expression *vimādhāgh* for 'curing' (Vd. VII, 38) deserves attention, because it is akin to Latin *medeor*, *medicus*, *medicina*. Compare, for the whole, Spiegel, *E.A.* vol. iii, pp. 581–582.

Diseases were of course considered by the old Irānians to be the creations of Evil. They make their appearance in numberless forms. There are ten thousand, as the Bundehish asserts [1]. Angra Manyu created them on earth to damage the pious people. But Ahura Mazda set bounds no less to this plague than to all other works of the demons He made the healing plants to grow, by the juice of which patients are healed [2].

Fevers chiefly are endemic in ancient as well as in modern Irān. They appear in different forms, and are, therefore, denoted in the Avesta by different names. Some of those names, for reasons which are apparent, originally mean 'flame' or 'heat [3].'

The puerperal fever in particular is also mentioned in the Avesta as occurring to women in child-bed, and often endangering their lives. Like all other fevers, it is accompanied by a tormenting thirst [4].

Women, moreover, are exposed to divers diseases Among them the Avesta mentions the disorder of the *menstruum*, consisting in an abnormal duration of hemorrhage [5].

Head-aches also afflicted the Irānian [6] *Caries*, or consumption [7]—the term in question is obscure—destroyed the

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[1] *Bdh.* IX, 4; West, 'Pahlavi Texts,' part 1, p 31.

[2] Vd. XX, 3–4; XXII, 2

[3] *Dazhu* (Vd. XX, 3), from rt. *daz* = Skr. *dah* 'to burn.' Next comp. *tafnu* = Phlv. *tapashn* (N.P. *tabish* 'febris'); *sārasti* or *sārastya* (Phlv. *garm* 'heat, flame'; according to Darmesteter, Vd. p 221, n. 1, it must mean the ague); *naẹza* and *naezaghh* (Phlv. *tanput* = N.P. *tanbad* '*rigor febris*, feverish chill;' yet in Yt. XIV, 33 it is used metaphorically for 'fire').

[4] *Yezicha · hẹ̄ · hãm · tafnō · jasāt · avi · tanuyē · zōishnuyē, yezicha · hẹ̄ · dva · yaska · avi · achishtō · ājasāt, yascha · sudhō · yascha · tarshnō*, Vd. VII, 70. The word *zōishnu* may be connected with the root *zan* 'to bear (children).'

[5] Vd. XVI, 8 seq. I will no longer assert with confidence that *pishtra* and *skeñda* in Vd. V, 59, denote sexual diseases.

[6] *Sārana*, from *sāra* 'head.'

[7] *Vazemnō-asti*. Consumption, as a consequence of unnatural practices, is probably meant in Vd. XVIII, 54 by 'we dry away from him his tongue and his fat.'

strength of his body. An excess of sexual desire [1] might likewise become a sort of disease.

A grave national evil existed in divers cutaneous disorders, among which I shall only specify the itch. Most terrible was leprosy, which covers and destroys the body of the patient. It rages now-a-days too all over Central Asia and certain tracts of Persia [2].

The bite of snakes caused death by poisoning. This may be understood by 'the calamity caused by serpents,' spoken of in the Avesta. Some plants, too, contained deadly venom, which might be fatal to the incautious [3].

Furthermore, there are enumerated in the Avesta a series, for the most part of bodily defects and infirmities, which were regarded as emblems of the evil spirit. There were people with a hump on their breasts or backs, stammerers, dwarfs or hunch-backed people and such as had overgrown teeth [4]. To these must be added the blind and the deaf, the halt and the lame, the dumb and the idiotic. They are all marked by the devil [*disease*] and therefore excluded from the sacrifices of the pure *yazata* Anāhita [5].

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[1] *Vāvereshi* (Yt XIII, 131) is certainly connected with Skr. *vṛsh*, *vṛshan*. In Vd. VII, 58, which may be regarded more or less as a parallel passage, we read *aghōsti*sh · *pourushu* · *asti* · *varesō*, but the text is corrupt. I should like to change the first word into *aghao*sh*ti*sh (cf. *maidhyoshema*, perhaps for *maidhyaoshma* according to *ZddmG.* vol. xxxv, p. 666), 'evil desire,' from *agha ush*ti.

[2] *Garenu* = N.P. *gar*, and *pāman* = Skr. *pāman* 'itch'; *paesō* · *vīta-retō-tanu*sh = N.P. *pēs* 'leprosy.' Cf. Polak, *Persien*, vol. ii, p. 305, Schuyler, *Turkistān*, vol i, pp. 147–148

[3] *Azhi-kar*sh*tem ibaeshō.*—*Kapasti* = N.P. *kabast* 'poison.' I must pass over other names of diseases, as *azhana*, *azhahva*, *kurugha*, *duruka*, since they are not intelligible.

[4] Vd. II, 29: *frakava*, *apakava*, *apāvaya*, *kasvi*, *vīmitō-dañtan.* The translation of the different terms is based upon tradition.

[5] Ys. V, 93. *Añda* = Skr. *andha* 'blind.' *Karena* 'deaf,' comp. Tomaschek, *Pamirdialekte*, p. 83 (Skr. *karṇa* 'ear'). *Drva* perhaps = *dhruva* 'fixed, not being able to move,' hence 'lame.' *Mūra* = Skr. *mūra* 'silly, idiotic.' *Ara* may perhaps be derived from the root *rā* = Skr. *rā* 'to utter a sound,' with the primitive *a*, hence

'Healing by means of sayings (māthra)' was considered the chief and most efficacious kind of medical treatment[1]. But nobody could utter religious sayings and prayers more efficaciously than priests. The physicians, therefore, belonged to the priestly order

If prayers had not the wished-for effect and if the demons of disease would not depart from the patient, the physician was called in to help by his skill. According to the kind of disorder, therapeutics or surgery, 'the cure by means of plants' or 'the cure by means of apparatus' was employed[2].

The best healing powers have been given by Ahura Mazda to plants, especially the poisonous ones. In them deadly and healing qualities are combined[3]. To water also healing power was attributed both by the Irānians and the Indians[4]. Hence it is that Amertāt and Harvatāt, the genii of a long and healthy life, preside over water and plants

The art of curing was thought very ancient. Its origin is traced back to the divine beings by tradition. This art was greatly valued by the Avesta people. The last three chapters of the Vendidād are almost exclusively devoted to it, and it is here that its origin is described.

*Thrita*[5], we are told, was the first 'of the helping, prudent, powerful, intelligent and rich men belonging to the

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'dumb.' Finally, *ragha* comes from the root *ragh*=Skr. *las* 'to hobble.'

[1] *Māthrō-baeshaza* (Vd. VII, 44). The *māthra* and *vachāo* are expressly called *baeshaza* or *baeshazya* 'healing, curing.' Vd. IX, 27; X, 5; Yt. III, 5.

[2] *Urvarō-baeshaza* and *karetō-baeshaza*. Vd. VII, 44.

[3] Comp. *vish-chithrem* 'a remedy coming from poisonous plants

[4] Comp. Rv. I, 23. 19–21; Zimmer, *AiL.* p. 272.

[5] Av. *Thrita* corresponds to the Indian *Trita*, to which, as is known, the Greek Τρίτων, Τριτωνίς, Τριτογένεια are correlative. Evidently *Trita* was, originally, the deity of the water, either celestial or terrestrial. Since water was considered to possess sanative qualities, he might fitly be made the inventor and protector of medical science.

family of the *Paradhāta*,' who fought against sickness and death[1]. At his request Mazda causes the numberless multitude of healing plants to grow[2]. It is also he, according to tradition, who first contrived the double mode of treatment, either by plants having medicinal qualities or by surgical operations With native simplicity he is said to have requested from Ahura Mazda as a boon a medicine coming from poisonous plants, and a metallic knife[3].

Medical treatment did not extend to men only, but also to beasts[4]. There are special precepts regarding the efforts which must be made in order to cure dogs that have run mad. Medicine should be administered to them entirely in the same way as to man. If this is done in vain it is permitted to use violence[5].

He who intended to practise medicine was obliged to undergo a kind of preliminary examination, in connection with which the most characteristic feature was that surgical experiments were made on unbelievers. If they died under awkward hands, the loss was not considered a great one.

If he who underwent the examination failed in three operations, he was incapable for ever of becoming a physician. If, nevertheless, he practised medicine, and if one of his patients died in consequence of injudicious treatment, it was imputed to him as intentional murder. But if, on the contrary, he succeeded in three operations and the patients recovered, he was allowed to practise without any restriction[6].

If the physician was called to a sick person, he was obliged to answer the summons as soon as possible. But the Vendidād deprecates hastiness in the treatment of the sick. Great importance was evidently attached to a correct diagnosis. The physician must observe each symptom of

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1 Vd. XX, 1–2.

2 *Urvarāo · baęshazyāo.* Vd. XX, 4.

3 *Vish-chithrem · dim · ayasata · āyapta · khshathra · vairya*, Vd. XX, 3. The last term denotes firstly 'metal,' then 'a metallic tool,' 'a knife,' as in Vd. IX, 9.

4 Vd. VII, 43.

5 Vd. XIII, 35 seq.

6 These regulations are found in Vd. VII, 36–40.

the disease and learn its nature before he decides on this or that remedy. If a disease has begun in the morning, the treatment is to commence in the day-time; if during the day, it shall be commenced in the night; if in the night, the physician has to commence by day-break[1]. This is a precept that was certainly dispensed with in cases of emergency.

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The fee—which, it seems, was to be paid only after a successful cure—is laid down already in the Vendidād[2]. In speaking of the fee of a physician I enter upon the investigation of a very important matter in the civilization of the Avesta people, viz. the question of money.

The fee differs for men according to rank and calling, for beasts according to their utility. A priest is to be cured for a blessing. Therefore, he pays no taxes.

For curing the master of a house, the head of a village, the president of a community, and the sovereign of a country respectively, there should be paid an ass, an ox, a horse or camel, and a carriage with four horses. For ladies, payment must be made, according to their rank, of the corresponding female beasts, a she-ass, a cow, a mare or a she-camel. The cure of a child of a family, particularly of a son, seems to have cost a horse. For curing a domestic animal the one next in value was always given; for a horse a cow, for an ox an ass, for an ass a sheep, while, last of all, bread and milk were given for a sheep.

We see that natural products, especially domestic animals, were the regular medium of payment. Thus the circumstances of the Avesta people were quite similar to those of the old northern nations and of the first epochs of Rome. In the one, cattle were regarded as the standard of value and

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[1] *Yęzi · uzirōhva · mereñchaitē, arezahva · baęshazyāt; yezi · arezahva · mereñchaitę̄, khshapōhva · baeshazyāt, yezi · khshapōhva · mereñchaitē, ushahva · baeshazyāt*, Vd. XXI, 3. 'The sickness' is here the grammatical subject. *Mereñch* cannot mean, of course, 'to kill,' but only 'to hurt, to prove hurtful.' Comp. Skr. *mṛch*.

[2] Vd. VII, 41–43.

money[1]; in the other, all bargains were originally effected by bartering domestic animals, and coined money was not substituted before the legislation of the decemvirs.

Even in the making of contracts cattle or sheep were given in pledge, according to the precepts of the Avesta. He who violated or revoked such a contract had to give, according to the agreement, one or more head from his herd or flock.

The fee payable to a priest for performing the purificatory ceremonies was settled in domestic animals just like the fees of physicians And here it is expressly laid down that the beasts themselves shall be given as far as practicable. Only in exceptional cases it was allowed to expiatea fault or transgression by giving other movable goods[2].

No proof can be adduced that we ought to understand by movable goods also coined money. On the contrary, this is contradicted by all other conditions of commerce. Wherever coined money is once known and in general use, it is impossible to think that payment in animals can be customary or desirable, even in the case of priests, to whom such property in animals could not but be inconvenient, considering that the nature of their duties constantly called them away from their own homes.

At most, it might be conceded that the nobility amassed, here and there, in their houses, trinkets, jewels and other precious things which might perhaps serve as means of payment in some cases[3].

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[1] Weinhold, *Altnordisches Leben*, p. 202.

[2] Vd. IX, 37–39 '. . If they can afford it, the Mazdayasna shall deliver to that man these animals from out their herds or flocks. But if they cannot, they shall replace them by *some other goods* (*anyãm* · *avaretanãm*).' This translation of the passage, according to which the animals are evidently considered as being themselves *avareta*, proves that movable goods in general are only meant by it. The same is apparently signified by *shaeta* or *khshaeta* ( = Phlv. *khvâstak*). If this is given as *weregild* 'compensation for a murder' (Vd. IV, 44), we cannot doubt that horses, cattle or sheep are meant more than anything else.

[3] This might be inferred from Yt. XIII, 67: 'Just as a man,

Similar circumstances are found at least among cognate nations in a similar stage of civilization. So it is with the ancient Germans and the Indians of the Rig-veda. 'The chiefs of the Germans pay by means of horses and jewels, excellent horses and rings are given as gifts of honour; horses and jewels are very often granted as rewards in "Beowulf" The same is the case with the Vedic tribes: *Nishka*, a golden ornament for the neck or breast, serves as a present together with horses. "A hundred *Nishka* were given me (says the poet of *Kakshivant*) by the king who stood in need; with a hundred horses I was presented in one day."'[1]

Of course we cannot speak properly of commercial intercourse, where a system of currency was entirely wanting. It was, I suppose, limited to the exchange of natural products between neighbouring communities.

But the desire to enter into commercial relations with other provinces cannot be said not to have existed in the time of the Avesta. The attempt was made to construct the first bridges and ways. The building of bridges in particular is highly meritorious, since streams and rivers are among the greatest obstacles to commerce[2]. In the garden *Vara*, laid out by Yima (who during the great deluge finds here an asylum with his family), there are bridges and roads, as signs of good order and management.

In conclusion, I shall mention some of the standards of measure used in the Avesta.

A dry measure used for grain and even for liquids was the *Danare*[3]. I cannot say how much it contained.

a valiant warrior, armed and watchful, drives (the enemies) away from his collected treasures (*hush-hãm-beretat* · *hacha* *shaetāt*).'

[1] Zimmer, *AiL.* p. 259.

[2] Comp. Vd. XIV, 16; XVIII, 74. 'Way' is *maregha* = Skr. *mārga*, (Vd. II, 26). 'Bridge' is *peshu* ( = *peretu*, from the root *par* 'to pass over'), originally only a natural food. The bridge supported on piles or pillars is called more specifically *fraschinbana* (cf. *skemba*, Skr. *skambha*). Also *haętu* = Skr. *setu* means, I think, both 'ford' and 'bridge.'

[3] According to Vd. XVI, 7, a menstruating woman is to receive for (daily) food one Danar *tāyūra* (?) and two Danar *khshāudra*. De

The smaller linear measures are taken from parts of the human body, and especially the *finger*. Sometimes, too, the uppermost joint of the middle finger is employed as a still smaller unit. Then follows the *span*, next the *ell* (the fore-arm from the top of the finger to the elbow), and, finally, the whole *arm*[1].

The *foot* served for a further unit of measure; three feet make a *pace*[2].

A greater length was determined by the *Hāthra*. Three or four made a *Parasang* (*Farsang*)[3]. A very interesting measure of length is the *Chartu* Like the stadion of old Greece it seems to have been the length of the race-ground settled by use. But it might perhaps have been the distance made by a horse and his rider in *one* run[4]. In this case the length of the *Chartu* would be entirely vague and unsettled.

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## § 22. *The Settlements of the Avesta People.*

THE Avesta contains a whole series of expressions, having the general signification of 'colony' or 'settlement.'

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Harlez (*Av. tr* vol. i, p. 235, note 5) observes regarding the *dānare*: 'Mesure de capacité ou de poids dont la base est une certaine quantité de grain. Elle paraît peser environ 700 grains.'

[1] 'Finger'=*erezu* (the Skr *dishthi* also is a linear measure, see B.R *sub voce*); 'finger-point'=*tishti*, Vd XVII, 5, and 7, 'span'=*vītasti*, N P. *bīdast*; 'ell'=*vībāzu*, *frabāzu* (Skr. *prabāhu*) or *frārathni*·(Skr *aratni*); 'arm'=*bāzu*=Skr. *bāhu*

[2] 'Foot'=*padha*, as in *thripadha* and *navapadha*; also=*gāya* as in *açvō-gāya* and *thri-gāya*. Vd. IX, 8, and 10.

[3] Justi (in his *Hdb.*) says that the word *hāthra* denotes 'A measure of distance 1000 feet longer than a *parasang*.' But compare the different meaning of it given by West, *Pahlavi Texts*, part i, p. 46, note 5, and p. 98, note 2; *Bdh.* XIV, 4; XVI, 7, 29.

[4] *Charetu* is, indeed, connected with the root *char* 'to run,' and *chareta* 'race-ground.' The 'Vara' of Yima is said to be a *chartu* long in every direction (Vd. II, 25). The tradition translates the word by *asp-rās* 'horse-way.'

Sometimes they designate merely the relations in which the individual lives with his family and his domestics, sometimes the hamlet or the village, sometimes even the entire district attached to it, sometimes the country, so far as it is in general cultivated and inhabited, in opposition to the surrounding unoccupied regions[1].

[1] The most important expressions may be traced partly from the root *khshi*, *shi*=Skr. *kshi*, partly from *had*=Skr *sad* 'to sit down,' partly also from *karesh*=Skr. *kṛsh* 'to make furrows, to cultivate the field.' To *khshi* belong:—1. *Shiti* (such as *hu-shiti*=Skr. *su-kshiti*, next *rāmō-shiti* 'quiet, secure settlement,' and *dareghō-shiti* 'lasting settlement', *yāirya hushiti* 'yearly, good dwelling' is to be particularly noticed, because in this expression an allusion is contained to a changing of the field)—2. *Shōitheman* in *hushoitheman* and *shayana*. The last one means the land generally inhabited, hence *airyō-shayana*. Gava is a *shayana*, i.e. the habitable part in Sughdha, Khnenta in Vehrkāna, Vaikerta in the land of the Duzhaka—3. *Shōithra* is the 'field.' Hence this word stands together with conceptions such as *gaoyaoiti* 'pasture-ground,' *maethana* 'dwelling,' *asagh* 'district' Cf also *shōithrya · apascha · zemascha · urvarāoscha* p 207, note 3. In Ys. 31 16 *shoithrya* stands as elsewhere *zañtu*.

To the root *had* belong *hademan*, 'settlement,' and *hadish*, meaning the same. The latter word occurs thrice in the Vispered with the characteristic epithet 'rich in fields.' The former one belongs to the Gāthā dialect. To *karesh* belongs *karsha* in *karshō-rāza* 'founding, disposing and ruling settlements.' With this compare Ys. 11. 2: 'The horse curses his rider. In future shalt thou not trap, mount, or rein a courser, as thou implorest not for strength for me in the numerous community, in the settlement abounding in heroes.' From the Old-Indian *kṛshṭi* and *charshani* may be taken for comparison, particularly *pañcha-kṛshṭayah* or *charshanayaḥ* 'the five tribes.' With such names the Arians characterize themselves with pride as a nation pursuing agriculture. (Comp. also Joh. Schmidt, *K.Z.* XXV. p. 89). In the Avesta *karshivat* still denotes the rustic or peasant.

Further expressions are: *maethana*, *maęthanya*, and *maętha* 'lodging, dwelling, premises of a farm.' According to Yt. XIII. 57, *maethana* must concur with *shōithra*. Worthy of notice are also such formations as *asagh*, *shōithra*, *gaoyaoiti*, *maęthana*, Ys. I. 16, II. 16, III. 18, where *maęthana*, I believe, denotes

This of itself proves what importance fixed settlements had in developing the civilization of the Avesta nation. It may be said with perfect justice that they generally formed the central point of their entire economical, religious and political life. The settled agriculturists and breeders of cattle are on the one side, and the homeless, restless, wandering herdsmen are on the other. these are the two great bodies, sharply opposed to each other, into which the inhabitants of ancient Irān were divided.

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'house and farm' as opposed to field (*shōithra*) and meadow (*gaoyaoiti*). Herewith corresponds Ys. X. 7, *ahē · vīsē uta · maethanem* 'village and farm.' These words belong, according to Geldner (*Metrik*, pp. 147 and 156, note 16), to the commentary.

Also *gaetha* denotes frequently 'settlement, premises of a farm' Thus in the word *hadha-gaetha* 'inmate' It originally means 'possession, property' (*vide* p 170, note 3), from root *gi*=*ji* 'to conquer, to obtain by victory, to acquire.' Comp. Skr. *jaya*, which has quite the same meaning. Then *gaetha* often means 'people,' particularly, I think, in such expressions as *ashahē · gaethāo* 'people of the pious,' Ys. XXXI. 1; Yt. V. 34, XIX. 41 and 93. The transition of meaning from 'settlement' to 'people living in settlements, settlers,' is found also in Skr *kshiti* and Av. *hademan*. To the Av. *gaetha* corresponds Old-Persian *gaithā* The word stands near *mānya*, and denotes evidently the whole farm together with the farm-buildings as opposed to the dwelling-house in particular There is no doubt that *gaetha* often means 'the herds.' I include here chiefly *drvō-gaetha* 'possessing healthy herds,' which stands near *haurva-fshu*, further Yt. VIII. 29, where *vāstra* and *gaetha*, 'fields and herds,' are combined.

It would be very interesting if we could ascertain whether *khshathra* (certainly=N. P. *shahar* 'town'; should that word come from *shōithra*, it must sound *shēhar*) may mean 'fortified settlement.' It is striking that all the passages which may be adduced as proof, belong to the Gāthās. Comp. Ys 45. 9 and 46. 16, but chiefly 34. 3, where it is said that the farms lie in the fortified settlement (*vīspāo · gaethāo* · ā · khshathrōi). If the translation be correct, we might ascertain in the case of Irān, the normal development of the town from the village surrounded with wall and trenches.

Finally, I mention *vīs* 'village,' and *nmāna* 'single farm,' of which I shall speak further on.

Though my present subject is, therefore, the system of settlement adopted by the Avesta people, still I must again discuss all its social features. In the section on 'Cattle-Breeding and Agriculture,' I have only dwelt upon the extent to which the economical life of the Avesta people had developed itself; in order to avoid repetitions I have not in the first place considered the course of that development. This historical part of the question must here necessarily appear in the foreground as far as possible. The chief point now is to trace the natural beginnings of the division mentioned above, and to show how the separation became wider and wider in course of time. It had become gradually more and more hostile and incompensable, since one portion of the nation began to advance vigorously on the path of civilization, while the other remained stationary in its earlier stage of culture.

Fixed habitations are to the old Irānian the *beau-ideal* of good fortune, of rest, and of peace. They are a gift of the heavenly ones. Tishtrya is called 'the dispenser of the field.' He and Mithra bestow good and peaceful settlements and long-lasting habitations [1].

In quite a similar manner the Vedic Indian in his hymns prays for 'good settlements' from the Gods. Indra, Agni, Soma, grant them to the pious man [2]. To him before all they belong, who stands under heavenly protection. Or they are possessed by the powerful ruler who protects his people with a strong hand and keeps away the enemy from his borders [3].

Settlements can be naturally founded only in such places where there are rich pastures for cattle and sufficient arable land. Hence they are called 'the rich in fields.'

> 'When will, O Mazda! at the same time with piety, devoted sense

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[1] *Shōithrahē · bakhtare, hushayana, rāmō-shiti, dareghō-shiti* are in Yt. VIII. 2 and X. 4, appellatives of the two genii.

[2] *Sukshiti* (=*hushiti*), Rv. II. 10. 8; X. 20. 10; V. 6. 8; VI. 2. 11; I. 91. 21; IX. 108. 13.

[3] Rv. I. 40. 8; VII. 74. 6.

Fall to our lot, and together with power a good
settlement rich in fields[1]?'

The loyal attachment to it is closely connected with the high regard entertained for the settlement. The nomad roves from one pasture-ground to another; whenever he finds fodder for his herds, he halts; when there is none left he carelessly advances further

The settlers on the other hand display their native feeling. They foster a noble love and reverence for the land already cultivated by their ancestors and inherited from them. It is an injustice and a shame to abandon them. This is doubtless implied in the words:

'May we be such as preserve their settlements,
Not such as forsake them[2].'

Let us transfer ourselves to that period of time in which the Arian or Indo-Irānian tribes advanced gradually from their original home towards the south.

It is well known that even thus early agriculture was no longer foreign to the Indo-Germans. The breeding of cattle was, however, paramount. When, in their wanderings and migrations, the Arians took possession of the districts on the northern slope of Paropamisus, they naturally led a life at least half-nomadic. Though they were not continually in motion, still we may assume a constant change of pasture-lands in winter and summer.

The breeding of cattle amongst the nomads, however, is everywhere on a large scale, while the mode of agriculture

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[1] Ys. XLVIII. 11 *hushitish* · *vasti avaiti*. Cf. Vsp. IX. 5, the epithets *ashavat* · *vāstravat* · *marezhdikavat* · *hvāthravat* with *hadhish*. As here, again, *asha* stands near *vāstra*, it may be taken for 'corn, bread,' as in Vd. III. 3 (*vide OIK*. p. 235, note 2, and p. 408, note 1). *Hvāthra* is naturally to be separated into *hu-āthra*, and opposed to *duzhāthra*.

[2] Yt. X, 75: *buyama* · *tē* · *shōithrō-pānō** *mā* · *buyama* · *shōithrō-irichō*. The glossographers add here the current ideas *mā* · *nmānō-irichō mā visō-irichō*, &c., which appear to be a gloss, even because *shōithra* stands first, what is certainly not conformable to the system.

which they pursue is characteristic as wasting to the soil. Wherever they repose with their herds a suitable piece of land is brought under the plough to produce the necessary supply of corn. The pasturage having been consumed and the single harvest got in, and the colder season returning, the exhausted soil is abandoned and another district is visited.

The nomadic way of living presupposes in consequence a very extensive territory with a thin population. With the increase in the number of inhabitants, people are obliged to remain content with a more confined space. The change of pasture-lands according to the seasons is discontinued. In colder districts on mountains a kind of husbandry peculiar to them takes its place; cattle are fed in stables during winter, and driven over the mountain-pastures during summer.

The abode becomes a permanent one, and houses of a more solid kind are naturally constructed. They are built to last longer and are more adapted to the requirements of the climate. The soil occupied is worked with the utmost regard to its capabilities; a ruthless and exhausting mode of cultivation would merely harm him who pursued it. More attention is paid to agriculture because relatively it pays better than the breeding of cattle. At the same time agriculture becomes more imperative, since a change of the fields no longer takes place, and the management of the farm becomes also more rational and systematic. Slowly and gradually, and not by violent fits and starts, takes place the development by which the nomadic tribes are changed into a settled nation devoted to agriculture.

To this transitional stage the Arians had evidently arrived even before their separation. But arable soil is not to be found in abundance even in the Hindukush districts. I might therefore believe that it was actually the want of such a soil which induced the Indian tribes to emigrate through the Suleiman passes.

Of the Irānian tribes, several persisted in their nomadic way of living. But those whom we designate as the

Avesta people are, in the earliest epoch when we hear of them, already in that stage of transition.

Here we have in my opinion reached a point where a very important difference prevails between the Gāthā period and that of the later Avesta.

In the Gāthās the 'cow' is the peculiar centre of the economical life. Agriculture is by no means unknown, but it is far from occupying the same place as the breeding of horned cattle. The perfection of the latter indeed is probably also a characteristic mark of the transition from nomadic life to fixed settlements The more easily moveable small cattle, such as sheep and goats, form the principal property of wandering herdsmen.

Ahura Mazda is in the Gāthās emphatically called the 'Fashioner of the Cow.' It is He who created her for the benefit of mankind. The divine spirits themselves take care that she may find sufficient pasture. Several epithets of honour are conceded to her[1]. Nay more, an entire hymn treats exclusively of the wrongs and oppressions which she endures at the hands of her enemies the nomads. The heavenly powers themselves consult how that evil may be checked, and promise to send Zarathushtra as a saviour and helper upon the earth[2].

It is erroneous to assume that the growth of agriculture led the nation to settle down in permanent dwellings. The development of agriculture on the contrary is frequently the result of a more fixed establishment, both of which, however, are in turn perfected by a more studied and rational cultivation of cattle-breeding, especially the breeding of neat-cattle.

This the poets of the Gāthās knew very well:

'She, the cow, gave us good settlements and prosperity
And estates, she that was longed for by the good;

[1] *Gēush*·*tashā*, epithet of Ahura, Ys. XXIX, 2; XXXI, 9; *yē* · *ahmāi* · *gām* · *rānyō-skeretīm* · *hēm-tashat* 'who created for us the delight-bestowing cow,' Ys. XLVII, 2. Besides *rānyō-skereti*, chiefly *hudhāo* 'bestowing good things' occurs as an epithet of the cow, which epithet is also usual in the later Avesta.

[2] Ys. XXIX.

For her caused the plants to germinate according to the holy order
Ahura Mazda from the beginning of the first world[1].'

And how at this time agriculture and the breeding of neat-cattle mutually influenced each other is expressed in the following stanza:

'But she, the cow, selected of those two the active countryman for herself
As her pious lord, the guardian of the good mind.
But he who did not follow agriculture did not participate in the good religion, though he attempted to deceive[2].'

So also the Gāthās. But on the other hand quite a different picture is presented in the younger Avesta. But here also the possession of herds is highly esteemed. Mithra is called 'the bestower of herds[3].' The yazatas are entreated for bullocks and horses, and their possession is looked upon as a gift of grace from the heavenly powers[4]. But the 'cow' does not in the least figure so prominently as in the epoch described by the Gāthās.

The economical development has continually and regularly advanced. Agriculture has undergone important technical improvement. At this time it is no longer of secondary consideration, but stands on the same level with cattle breeding; in fact it even appears to surpass the latter in value and importance[5]. That transition which began in

[1] Ys. XLVIII, 6. *Hā* at the beginning of the stanza refers doubtlessly to *gavōi* of the precedent stanza; *vaghēush managhō · berekhdhę̄* refers to *hā*, and is probably nom. sing.

[2] Ys. XXXI, 10. In line 2, on account of the metre, it is required to read *fsheñghīm* (Spiegel, Comm. II, 243), which has no difficulties at all, because of the following *m*, and admits also of an orderly construction. Cf. Roth, *Yaçna*, XXXI, pp. 8–9, 24–25. One feels induced to translate *vaghēush managhō* here and in other passages in the Gāthās directly by 'cattle.'

[3] *Vāthwō-dāo.* Yt. X, 65.

[4] Yt. X, 28. Cf. above, p. 176.

[5] This is clearly to be seen from Vd. III. 4–5, where agriculture and cattle-breeding are mentioned together, and even agriculture before cattle-breeding.

the Arian period and continued in the Gāthās, is now complete. The Avesta people have become a firmly-settled nation of agriculturists.

I must here again lay stress on the fact that in the Gāthās the opposition is really not between herdsmen and husbandmen, but frequently between the nomads and the settled population. To the latter did the proclaimer of the new religion address himself. Amongst them did the new religion first find acceptance.

'For that I ask Thee, give me the right answer, O Ahura·
How shall I maintain pure the doctrine
Which shall be proclaimed before the liberal prince
As the true supreme power and as the best doctrine by thy follower, O Mazda,
Who lives *amongst the settlers* with piety and good mind[1]?'

'O Zarathushtra, who is thy pious friend
In thy great work? Who is it that wishes to announce it?
It is he himself, Kavi Vishtāspa, the one armed for battle,
And those whom besides, O Mazda, Thou selectest *from the settlers*,
Those will I praise with the prayers (*māthras*) of the pious mind[2].'

With the spread of the new doctrine therefore the increase of settlements goes hand in hand. When a hitherto nomadic tribe becomes converted to the Zoroastrian religion, it abandons its former unsettled mode of living, builds permanent dwellings, and cultivates the fields:

'For that do I ask Thee, give me the correct answer, O Ahura!
That is, for the doctrine which is the best of all that exists,

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[1] Ys. XLIV, 9.

[2] Ys. XLVI, 14. *Hadēma* is, of course, not to be separated into *ha* + *dēma*, but stands for *hadema* = Skr. *sadman*.

Which, when it is followed, multiplies for me piously the settlements.
Together with the words and works of devotion may He grant it to me rightly!
My soul's wishes crave for Thee, O Mazda [1].'

'For this end do I approach Thee, Blissful Spirit,
Ahura Mazda, Thou Commander through the good mind.
Through Whose deeds the settlements are piously increased;
To them does their devoted sense teach the precepts
Of Thy Spirit, Whom nobody can deceive [2]!'

The divine beings support man in his work of civilization. Hence they bear the name 'increasing and furthering the settlements [3].' Ahura Mazda takes care of the farm-houses [4] and Srausha is called 'the protector of the settlements of the pious [5].'

The conversion of a Tūrānian tribe to Zoroastrianism is already noticed in the Gāthās. Through it the settled dwellings of those who are of 'devoted sense' are increased [6]. The Fryānas thus relinquished their nomadic life and joined the number of the settlers.

The adversaries of the Mazda religion are nomads. How these maintained their position near the settled population of Irān is explained by the condition of the soil.

Even at the present day in Afghānistān permanently settled tribes that pursue agriculture dwell near and amongst nomadic people. The Ghilzai, to whom the territory on the Tarnak river belongs, are partly wandering herdsmen and partly peasants [7].

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[1] Ys. XLIV, 10: *yā · mōi · gaethāo · ashā · frādhōit · hachēmnā.*

[2] Ys. XLIII, 16: *yēhyā* · sh*kyaothanāish* · *gaethāo* · *ashā* · *frādheñte.* The same formula see Ys. XIX, 17. Cf. Vsp. II, 5; III, 4, &c.

[3] *Frādhat-gaetha, varedhat-gaętha.*

[4] Ys. LV, 4.

[5] *Hishārō · ashahę̄ · gaęthāo.* Ys. LVII, 17.

[6] Ys. XLVI, 12; cf. p. 31.

[7] Masson, *Narrative*, II, 205; Elphinstone, *Kabul*, II, 172–175; Spiegel, *E. A.* I, 321 seqq.

The Sturiānī were originally nomads. Only a little before Elphinstone's sojourn in Afghānistān had they adopted agriculture and fixed settlements. A strife with a neighbouring tribe had narrowed their territory, and this necessitated a more careful cultivation of the soil.

The Shīrānī pursue agriculture; their neighbours the Vazīrī wander round about with their herds. So too the Nassers. These pass every autumn in constant warfare through the dominion of their bitterest enemies, the Vazīrī, in order to search for pasture-grounds in warmer districts during winter. In spring they return by the same way and amid the same perils to the cooler mountain-heights[1].

That nomadic tribes also embraced Zoroastrianism is not quite impossible, but it is also by no means certain

We know for a fact that the Mazdayasnān dwelt sometimes in tents which were subjected like other dwellings to purification enjoined by the Law. In the hut of an unbeliever the ceremonies of the Avesta would of course not be practised.

However, such could scarcely have been the case in more than a temporary way. Herdsmen who watched the cattle on their pasture-grounds may have lodged themselves in tents. It is also to be borne in mind that every dweller in a tent is not therefore a nomad. Many inhabitants of Afghānistān who pursue husbandry prefer the tent to a fixed habitation. This predilection appears to be a remnant of an earlier period, of a time in which the tent was indeed the sole homestead of the family.

What then was the usual form of settlement amongst the Avesta people?

As a rule the Mazdayasnān dwelt in *villages*. The village was composed of a certain number of dwellings, each of which harboured a family[2]

Thus it is said in a certain prayer: '*Into my house* may there come the contentment, blessing, guilelessness and appreciation of the pious men. May there now arise *for*

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[1] Elphinstone, *Kabul*, II, 90–91, 97, 212 seqq.; Spiegel, *E.A.* I, 309–310, 324.

[2] *Vīs* 'village'; *nmāna* 'a single habitation, farm.'

*our village*, piety and power, blessing and magnificence and happiness, and long-lasting dominion of the faith, which originates from Ahura and from Zarathushtra. Soon may there issue from our village cattle and corn (?) and the strength and adherence to Ahura, of the faithful men[1]!'

Into these villages the wolves secretly steal to seize their prey. The villagers stand under the special protection of the *manes*. The spirits of the departed ones also return to them annually at the season of *Hamaspatamaidhaya*[2].

By the last name are frequently designated the villages of the Mazdayasnãn. They are visited by the hordes of hostile plundering tribes, who suddenly rush upon them to murder men, to drive away their cattle and to carry away into cruel imprisonment their wives and children[3]. They therefore pray to the good spirits that the villages may be lasting, good and peaceful settlements, chiefly that there may not befall them any scarcity of water and failure of crops, which might compel the inhabitant to quit his beloved homestead and to search for new dwellings[4].

Along with the village system, there, however, also existed the *farm-like settlement*.

The reasons for different forms of habitations spring entirely from the natural conditions of the land, to which man adapts himself at all times and places with an instinct peculiar to himself for choosing that which is necessary and wholesome.

Extensive plains, be they low-lying grounds and deserts, or high plateaus, do not favour the foundation of fixed settlements. They are essentially the territory adapted to wandering tribes. Thus the nomadic mode of life and extensive cattle-breeding must have always prevailed on

[1] Ys. LX, 2–3. 'Corn' = *ashem*.

[2] Vd. XIII, 11 and 40; Yt. XIII, 49.

[3] Vd. XVIII, 12; cf. p. 28; cf. *kutha* · *nasu*sh · *apayasānē* · *hacha* · *avanhat* · *vīsat* · *yat* · *mazdayasnōit*, Vd. XIX, 12.

[4] Ys. LXVIII, 14: *hush*k*iti* *rāmō*-sh*kiti* besides *dareghō*-sh*kiti*. Ys. XII, 2–3: *us* · *māzdayesninãm* · *vīsam* · *zyānayaçchā* · *vīvā-patcha* (mod. Pers. *biyāb*) . . . *nōit* · *ahmāt* · *āzyāonim* · *nōit* · *vīvāpem* *khshtā* *māzdayasnīsh* *avi* *vīsō*.

the rather sterile elevated plains in the south of Afghānistān and on the steppes of the Caspian and Aral Seas.

Mountains, which of themselves render the free movement of larger masses of men and animals difficult, are usually the first cause of permanent dwellings. Even wild rugged mountain-districts appear at a very early period to have been inhabited by settled populations to as great a height as the climate would allow men to dwell in, the higher parts, however, being still available for pasture [1].

The expansion of the settlement is of course entirely dependent upon the condition of the soil Larger settlements can spring up only where continuous pieces of fertile land are found. If the cultivable soil consists on the contrary of broken and isolated pieces of smaller extent, interrupted by steppes or barriers of rock incapable of cultivation, the tendency to separate and establish independent farms and hamlets will predominate [2].

Finally, another consideration has likewise a mighty influence upon the security of life and property.

In an open country which is exposed to hostile inroads, people are always obliged to unite in one large community in order to enable themselves to make a successful resistance against their enemies. This is particularly the case where a nation of agriculturists have as near neighbours nomadic tribes who are indeed their natural and most dangerous enemies [3].

In mountainous countries, where nature itself offers the means of protection, the settler enjoys greater freedom. Here he can separate himself from his relatives and companions, and look for pasture and arable land according to his own taste. He can live as a free lord upon his farm independent of neighbours, unhampered by the restrictions necessary in a large community.

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[1] Andrian, '*Ueber den Einfluss der verticalen Gliederung der Erdoberfläche auf menschliche Ansiedlungen*,' in the transactions of the Anthropological Society of Vienna, vol. vi, 1876, pp. 2–6.

[2] Inama-Sternegg, *Untersuchungen über das Hofsystem im Mittelalter*, p. 7 seqq.; Roscher, *Nationalökonomik*, § 75.

[3] Andrian, l. c. p. 12.

These universal laws affect the most diverse nations of all ages and countries, and may be likewise applied to the condition of settlement of the Avesta people.

Under what circumstances larger communities are found is clearly seen when we fix our eyes upon the present boroughs of Eastern Irān. These are generally situated on the banks of rivers, where they pass from the projecting mountains into the plains or from fertile *oases* into the flat land. Here are combined the two requisites which chiefly render possible the rise of larger settlements.

On the one hand, the best arable land is really found at the foot of the mountains near the rivers and of sufficient extent to maintain a very large number of people. On the other hand, the edge of the plains is naturally most exposed to the pillaging inroads of the nomads. In fact, the large river valleys serve as roads through which to penetrate deeper into the mountains.

Andkhūi, Shibarghān, and more particularly Merv are towns which owe their existence to *oases*. The tracts between the flat land and the mountains are held by Kunduz, Khulm, Balkh and Sarakhsh. Siripūl, Maimane and Herāt lie in broad and easily accessible river-valleys, and indeed just in the parts where the valleys begin to narrow.

In the south, Farā, Girishk, Kandahār exhibit quite the same natural features. The last-mentioned town especially is founded with an exceedingly skilful adaptation to the nature of the ground. It lies on a plateau which is formed by the last projections of the mountain-range. On the west and the east it is sheltered by the Arghandāb and Tarnak, which unite below the town. The plain is thus on all sides naturally protected by these rivers, while the mountains rise in its rear.

Gazni and Kabul were probably built partly for strategical reasons and partly on account of the richness of the surrounding country in arable and pasture land.

In all these places native legends maintain the high antiquity of the towns.

Balkh is regarded as a populous and fortified town even

in the legends of Ninos and Semiramis, and is called the 'mother of towns' by the natives[1].

The foundation of Merv is ascribed to Tahmūrāth, the *Takhma-Urupish* of the Avesta[2] Kandahār is said to have been built under Lohrāsp, called Arvat-aspa in the Avesta[3]. On both sides of Girishk, ruins of great antiquity are found on either bank of the Hilmend. These are the remnants of an important town, which, according to the belief of the native inhabitants, flourished in the time of Alexander[4]. To the pre-Macedonian period must also belong the golden age of the ancient Farā; however, we do not know how far back in ancient times we are entitled to place it[5].

In conclusion, I have yet to mention the numerous and extensive ruins scattered over the plains of Seistan. They contain the remains of towns, castles and other buildings, whose erection is ascribed by native tradition to the sovereigns of the legendary dynasty of the Kayānians. The want of security against the pillaging Baluchees even now forces the inhabitants on the delta of the Hilmend to unite themselves into larger settlements.

On the rugged and rocky heights of the Hindukush and in the Alpine regions on the upper Oxus regular towns could not be erected. Here the natural circumstances are favourable to the establishment of smaller villages and hamlets, and even of single farms. Arable land is here found only in small fragments, which do not allow a large number of people to live together. The variegated character of the soil furthered the segregation of the inhabitants. The natural security of the country permitted the separation into small groups or into single families.

The existence of the farm-settlement along with the village-settlement can be proved also from the Avesta.

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[1] Burnes, *Bokhara*, II, 204; Ferrier, *Voyages*, I, 389 seqq.; Vámbéry, *Reise in Mittelasien*, 206.

[2] Burnes, *Bokhara*, III, 30 seqq.

[3] Ferrier, *Voyages*, II, 132, note 1.

[4] Ibid. II, 120.

[5] Ibid. II, 278–279.

The Vendidād, referring to the provisional places for the disposal of the dead body called *Kata*, contains the definite command that such *Katas* should be built *in each village* and *in each house*[1] Certainly it cannot be meant thereby that the whole community, and moreover each individual family, should have *Katas* of their own. That would be palpably absurd. The commandment is only intelligible if we take into consideration the co-existing forms of settlement.

Where people dwell there must be *Katas*, even in each separate farm-house, where it may prove necessary in the event of death taking place. For a village the building of one set of *Katas* is, however, sufficient. There they are evidently the property of the community, ready for use whenever a death occurs in a family residing in the village.

The Avesta people were not without enemies. Their exposed settlements were subject to sudden inroads of the nomads of the steppes, without taking into consideration that in threatened districts, where a larger number of people united themselves, measures had to be taken to ward off such dangers.

On convenient sites were built castles, which in time of war gave shelter to the women, children and herds, or else the village was surrounded with a wall and entrenchments. The way in which people secure themselves to this day in Khorāsān against the attacks of the Turkomans is similarly characteristic. Everywhere, even in the immediate neigh-

[1] Vd. V, 10; cf. p. 94. Also in Vd. VIII, 103 I recognize an allusion to the system of villages and farms, in that passage the last two words of *nazdishtem · avi · nmānemcha · vīsemcha · zañtumcha · dahyūmcha* are to be erased as glossarial additions; for it is nonsense to say that a man who has become impure, should run to the next district, or even to the next province and ask, with a loud voice, for the performance of the purificatory rite; whereas it is proper that this should be done at the first village or farm where he arrives. The wish to place together those four current expressions caused the awkward interpolation. Analogous passages are Ys. IX, 28 and Yt. X, 75; but I believe that, on a particular examination, still more passages would be found.

bourhood of the villages, towers are built on the fields. When the dreaded horsemen appear, the people who are on the open fields escape into the nearest tower, and maintain themselves there until either help arrives or the Turkomans withdraw.

As in the Avesta we have no direct evidence of any of the modes of defence mentioned above, we must confine ourselves to general observations[1].

Fortified places that stand vacant in time of peace and are occupied on the outbreak of a war, only fulfil their object to a certain extent. They are suitable where a regular war occurs, the outbreak of which may be calculated on with some certainty. Near the edge of a desert where war is more or less incessant, and where people have to be on their guard against sudden attacks every day and every hour, such fortified places serve no purpose. How could it have been possible on the alarm of a very sudden and wholly unforeseen invasion actually to convey women and children into the castles, and to collect the herds and drive them behind protecting walls?

Against such dangers there is indeed no absolute security. In addition to the union of a large number of warlike men, which inspired the barbarians with respect, the practice of always maintaining permanent dwellings in a fit state for defensive warfare offered the best protection. Whoever was surprised in the open country by robbers was infallibly lost. Only the lives and property of those who were sheltered behind walls were safe.

It is my opinion, therefore, that even in the most remote period *fortified* places were founded where the present Eastern Irānian towns are situated. The development of the town from the fortified village is quite normal.

[1] Very difficult is the passage Yt. V, 130, and therefore little fit for proving the fact; one might possibly thus translate it: 'I will set up a fence (*vāreman*) in the plains (*upa staremaęshu*), which protects all that belongs to livelihood (*hujyāitīm*), and makes to increase the power when it is necessary to withdraw' (*zazāitē*, dat. sg. of the pres. part. of rt. *zā*?).

I might even consider it as by no means improbable that the beginnings of the town-like settlements go back even to the age of the Avesta.

The point to be most considered here is, what we should understand by a 'town' Towns where houses are ranged one close to the other in regular streets, where the profession of the tradesman is held in the same honour as that of the agriculturists, yea, even surpasses the latter, and where commerce and mercantile pursuits flourish; such were unknown to the Avesta people

In the case of the Avesta people the characteristics of the village and of the town are so fundamentally different, that a particular name for the latter could not but be wanting in the Avesta language. Trade, besides, does not play in the Avesta nearly such an important part as cattle-breeding and agriculture. The entire life, as it is pictured to us, is the life of herdsmen and peasants. Commerce seems to have been completely unknown, and the conditions of intercourse, the exchange of products, purchase and sale, were evidently quite primitive.

If, on the other hand, we define the town as an enclosed and fortified settlement, constantly inhabited in all its parts, of larger extent and with more numerous inhabitants, the existence of town-like settlements amongst the Avesta people is at least probable. In that case the fortified village and the town properly so-called differ only with respect to their dimensions.

The large village ranks just below the town. Through the accession of fresh communities and the constant growth of population, circumstances are generally brought about, under which a real town life first develops itself.

The preliminary conditions for the formation of town-like settlements were offered, if anywhere, in Eastern Irān. The economical possibility of maintaining a larger number of people is limited to certain countries. But just where it exists, the insecurity of life and property combines to make the union into extensive communities necessary.

Here I refer also to the condition of settlements amongst the kindred tribes.

The practice of dwelling in open villages and boroughs was by no means so exclusively an Indo-Germanic custom as it is generally supposed to be. In every place where historical circumstances or the special aspect of the soil are conducive to it, people even at very early periods are led to the foundation of enclosed and fortified towns [1].

The Italici had already passed the stage of village life, while they still dwelt in the valley of the Po. Their settlements discovered there are without exception surrounded by trenches and walls of earth. They exhibit a systematical design in the form of a rectangle, and cover an area of three or four, nay, even of ten hectares [2].

The Germans, too, who still manifest in general a distinct inclination towards independence and separation into their settlements, abandoned the farm or village settlement even where the external condition made it desirable. The large settlements of the Quades on the March and the Danube are, therefore, characteristic. For instance, the village in the province of Braunsberg, which is surrounded with a large circular wall, covers an area of thirteen hectares, the space occupied by dwellings, the place of arms in Stillfried on the March, even extend over twenty-five hectares.

Such places, however, did not merely serve for refuge during war. On the contrary, discoveries made in them prove that they were also fully and constantly inhabited in times of peace [3].

The Gorodists of Southern Russia may also not have been mere castles to be used in case of war. The discoveries made within the circuit of the walls compel us rather to assume that those were constantly inhabited [4].

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[1] With the following cf. Pohlmann, *Die Anfange Roms*, p. 29 seq.,

[2] Helbig, *Beitrag zur altitalischen Kultur- und Kunstgeschichte, I, Die Italiker in der Poebene.*

[3] Much, *Transactions of the Anthropological Society of Vienna*, V, 39 seq ; cf. Inama-Sternegg, *Deutsche Wirthschaftsgeschichte*, I, 6–7.

[4] *Revue des deux mondes* of 1874, p. 795; Pöhlmann, *Die Anfänge Roms*, pp. 35–36; but see Zimmer, *AIL.* pp. 146–147.

As regards their dimension, it is true, they are considerably inferior to the enclosed villages of the plains of the Po, or to the settlements of the Jurades.

Finally, I come to the nation which is most closely akin to the Irānians—to the Vedic Indians. Here we have a very clear instance of how the geographical and historical conditions severally affect the form of settlement I place myself without any hesitation on the side of Zimmer, who denies the existence of urban settlements among the Arians of the Rig-veda.

'Nowhere do we meet with any certainty with the name of a town in the hymns of the Rig-veda. The people dwelt rather in villages, hamlets (*grāma*), which were mostly completely open. . . . The *pur* served as a defence against the attacks of enemies as well as against inundations; they were, as far as we can perceive, situated on elevated points, and were protected by mounds and entrenchments, within which people took refuge with their wives and chattels in the time of danger They may have been particularly abundant on the shores of rivers, for there the most obstinate battles were fought, according to the testimony of the Vedic hymns[1].'

Now nothing would be more improper than to transfer such conditions from the old Indians to the Irānians. Even subdivisions of the same people often display according to circumstances a great difference in their settlements. The Slavi lived, partly in entirely unfortified abodes, partly in regular and enclosed settlements[2]. The testimony of Tacitus regarding the division of the Germans into single farms and unfortified hamlets is by no means applicable to all tribes and districts. Italican peasants in the Apennines lived, even in the Imperial age, in small boroughs, whilst the Italici of the prehistoric period had already become builders of towns.

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[1] Zimmer, *AIL.* pp. 147–148.

[2] Thus, according to Prokop's descriptions, the advancing and therefore nearly nomadizing Slavi on the Danube. *Vide* Pöhlmann, *Die Anfänge Roms*, p. 35.

Thus the Vedic Indians and the Irānians of the Avesta, owing to the great difference in the nature of the countries in which they lived and of the historical circumstances which influenced them, may have and must have gone different ways.

We know how the nature of their soil must of itself have led the Irānians to the building of larger and enclosed settlements. To a great extent this was not the case with the Indians. The Indus valley and the Panjāb display, by far, greater uniformity in the aspect of the soil. It is a flat and open land which, of itself, conduces more to the splitting up and scattering of the people.

The chief point of difference is, however, quite another one. An urban settlement certainly presupposes a longer establishment in the land This is applicable to the Avesta nation who, so far as our information goes, dwelt in the districts north and south of Paropamisus.

With the Indians the case was entirely otherwise. The Rig-veda does not at all represent them to us permanently settled. The Arian people of that age are, on the contrary, continually moving. They advance slowly, from west to east, drawing near to the banks of the Ganges. One river-line after another of the Panjāb becomes occupied; the aborigines are more and more forced backward or driven into the mountains.

Under such circumstances a town-like settlement could evidently not develop itself. For the security of property the building of castles was sufficient. A circumvallation of the village was required only in isolated localities.

The troops marching at the head of the migrating Arian nations were engaged in constant and bloody wars with the Dāsa, and lived probably in a sort of military camp. The tribes living further back enjoyed a relative security, which was only disturbed by actual feuds between the Arians themselves.

Of such sudden invasions as the Irānians had to expect, the Rig-veda says nothing, to my knowledge. They were certainly not so common and not the usual form in which war was waged. The preparations which people made

against the impending dangers from enemies, must consequently have been entirely different in India from what they were in Irān.

Indeed, the settlements of the Arians of the Avesta and of the Rig-veda developed under totally different conditions. Accordingly the result must have been entirely different with the respective nations in spite of their close relationship, and notwithstanding all other uniformity of custom and culture.

In conclusion, I come to the question whether the founders and inhabitants of a village were bound together by relationship, or whether they had united themselves in settlements for any other causes, that is, whether the Eastern Irānian village was the village of kindred races or not.

The following explanation respecting the development of a village would appear to be the most probable one. Every individual man selected at pleasure his piece of ground, on which he settled himself with his family. The sons, when they were grown up and established their own homesteads, built their dwellings near that of their father. Around their farms followed afterwards those of grandsons and great-grandsons. The field was cultivated as a common property and its revenue divided [1].

Moreover, I consider this primitive development of the village of a family out of the single farmhouse as in many cases possible. That farm-like settlements were known amongst the Avesta people is not to be doubted. That the descendants of a head of a family settled in the immediate neighbourhood of the family mansion, rather than remove

[1] In that manner the Bohemian village is said, by Palacky, to be originated: 'According to him (Palacky), the Bohemian built his house in the midst of his landed property. His descendants managed the paternal estate, often during several generations, in common, and without dividing it; if the paternal house was not more capable of holding their increased number, other houses were built in the proximity, and this was the origin of the most ancient Bohemian villages that were as many in number as small in extent, since all their inhabitants originally formed but one only family.' Pöhlmann, *Die Anfänge Roms*, p. 51.

themselves to a distance from it, altogether corresponds with the old Irānian spirit.

Amongst the Parsees in Bombay a most highly remarkable custom exists even at the present day, in which the inclination towards the closest possible union of the respective families is strikingly manifest. Here the sons are not wont, even when they are grown up and married, to set up really independent households. So long as there is any room, they dwell, together with the other relatives of their father's family, in the house of their parents. Even if a man has six or seven sons, they all live, with their wives and children, with the head of their family[1]. We may also add that when any scarcity of room occurs and a new dwelling has to be occupied, the latter is looked for in the closest possible vicinity of the father's house.

The Tājiks also in Badakhshān live together in kindred families, and we may imagine that such is the case with the rest of the Galchas, of whose manner of life and customs we do not, unfortunately, possess any account.

In the whole of Badakhshān the villages, called *Kishlak*, exhibit the same design[2]. They are divided into several

[1] Dosabhoy Framjee, *The Parsees*, p 87.

[2] I give here a very interesting passage of Wood's *Journey to the Source of the River Oxus*; it is a very clear description of a Tājīk village in Jerm; the description may also be regarded as a kind of addition to p. 52:

'It is customary in these countries for relations to live in the same hamlet, often to the number of six or eight families. An outer wall surrounds this little knot of friends, within which each family has its separate dwelling-house, stable, and cattle-shed; and a number of such hamlets form a kishlak, or village.... The style of building does not differ throughout the country, and our quarters at Term may be taken as a fair specimen of them all. The site is the slope of a hill, and a rivulet is usually not many paces from the door. Its course is here and there impeded by large whitened boulders, glassy-smooth from the constant action of running water; while its banks are shaded by a few gnarled walnut-trees, and the lawn adjoining planted in regular lines with the mulberry. Down in the bottom of the valley, where the rivulet falls into the larger

quarters or hamlets, each of which is surrounded by a wall. In such a hamlet dwell families connected by blood, often six to eight in number. Each of them has its separate division, enclosed again by a wall within the hamlet itself, with its own dwelling and rooms for the household.

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stream, lie the scanty corn-lands of the little community The mountains rise immediately behind the village, and their distant summits retain their snowy coverings throughout the greater portion of the year. An enclosure is formed by running a dry-stone wall round a space proportioned to the size and wealth of the family. The space thus enclosed is divided into compartments, the best of which form the dwelling-houses, whilst the others hold the stock. These latter compartments are usually sunk two feet under-ground, while the floors of the rooms for the family are elevated a foot or more above it: flat roofs extend over the whole. In the dwelling-house the smoke escapes by a hole in the middle of the roof, to which is fitted a wooden frame, to stop up the aperture when snow is falling. The rafters are lathed above and then covered with a thick coat of mud. If the room be large, its roof is supported by four stout pillars, forming a square, in the middle of the apartment, within which the floor is considerably lower than in the other parts, and the benches thus formed are either strewed with straw or carpeted with felts, and form the seats and bed-places of the family. The walls of the house are of considerable thickness: they are smoothly plastered inside with mud, and have a similar though rougher coating without. Where the slope of the hill is considerable, the enclosing wall is omitted and the upper row of houses are then over the roofs of the lower. Niches are left in the sides of the wall, and in these are placed many of the household utensils. The custom of relations grouping together has its advantages, but they are not unmixed. Many of the sorrows of the poor are thus alleviated by the kindness of friends: the closeness of their intercourse adds to their mutual sympathy; and when death occurs, the consolation which the afflicted survivors receive from those near around them is great indeed. But to the newly married couple the benefits derived from this arrangement are frequently very dearly purchased; and the temper of the poor bride, it is to be feared, is often permanently damaged by the trials she has to undergo at the hands of a cross-grained mother-in-law.... Small as is the population in many of the valleys or narrow mountain glens, it is yet too great for the limited extent of their cornlands.'

Anyhow in my opinion, the foundation of single farms was at least an exception. As a *primitive* form of settlement they occurred in Eastern Irān, at all events, as seldom as in other countries and with other peoples, and especially for this reason, that the settlers, at least as I believe, had first to conquer the land from hostile aborigines, against whom they could naturally defend themselves only when in sufficient number Indeed, in low stages of civilization the dwelling together in a village offers eminent advantages. With the first seizing of a country the settlement is, therefore, everywhere by far more frequent than farm-like dwellings[1].

Eastern Irān was, without doubt, partly at least, already conquered by the Indo-Irānian tribes. The first settlements go back to the Arian period, and cannot therefore be conveniently designated as properly Irānian. But again, after the secession of the tribes, afterwards known as Indian, the Irānians, who remained, were by no means in a settled state. The battles with the aborigines continued also down to the Irānian period. In the spread of civilization there was no standing still. In the West particularly, cultivation was pushed more and more forward, and fresh soil was won. It is also certain that special Irānian families, as first settlers, often took considerable quantities of land into their possession, and a large number of primitive settlements owed them their origin.

When we have thus traced the rise of village communities from one another, the following question suggests itself as to the character of the Eastern Irānian village: Did the Irānians migrate in search of land in miscellaneous crowds and thus found settlements? or, had they already grouped themselves according to relationship and in tribes?

That the latter was the case is proved to a certainty. The word *vis*[2] does not designate the village locally only,

[1] Roscher, *Nationalökonomik*, p. 252 seq.; Pöhlmann, *Die Anfänge Roms*, p. 52.

[2] To the Av. *vis* corresponds Skr. *viç*; here it is important for the relation between the Irānian and Indian settlements that

but at the same time also genealogically the race composed of several families. It is only in the original actual combination of both these ideas, when every race built and inhabited their own village, that the double meaning of the single word *vis* is intelligible.

Often enough, indeed, this state of things was only the ideal and not the actual one. The principle of relationship was obscured by purely accidental or local circumstances. It also happened that smaller tribes, not originally related, united themselves into a common settlement, or that neighbouring, though not kindred clans, were formed into a large community for practical reasons.

But even such communities were evidently organized very much according to the old bonds of tribe[1]. The village of a clan formed the model according to which the new settlement was arranged and managed. The inhabitants of a village, founded by two or more families, then form only a single clan, under common direction, under *one* head If such were not the case, it would be impossible that the two-fold signification of *vis* could have been preserved fresh throughout the entire literature of the Avesta.

The conditions of settlement of the Avesta people are therefore very various, they are altogether adapted to the nature of the land in which those people dwelt. The village and farm systems existed side by side. Single farms were more rare and were found chiefly in mountain-valleys.

Villages were founded more frequently, and, indeed

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*viç* signifies in the Rig-veda 'house, family, race,' whilst 'village' is designated by *grāma*. Obviously the Indian village was principally a local bond, or at least, the identity of village and family is not more so manifest as among the Avesta people.

[1] It seems to follow from the inscription of Behistan, I, 65, that also in Western Irān the village of a clan was ordinary; there we must translate *gaithāmchā · mānyāmchā · v'ithbi*sh*chā* apparently by 'the settlements and houses according to the races.' The Medes and Persians had, therefore, settled according to races or clans; several related families formed the community of the village. Cf. Spiegel, *Altpersische Keilinschriften*, pp. 8–9.

naturally, in more open and more fruitful districts. As such places were particularly found on the *transition rocks* in the deserts, and exposed to the pillaging incursions of the nomadic tribes, the villages were surrounded with walls and trenches.

In the positions where the Afghān towns are now situated, the conditions favourable to the rise of more extensive settlements exist to a certain extent. Here there were probably already in the Avesta epoch, fortified villages of such a dimension, that we may justly speak of them as the first step towards the formation of urban settlements

As a primitive form of settlement the village was more common than the single farm The villages were villages of races; their inhabitants were bound together by ties of relationship But it must be admitted that from the original single farm-house also, sometimes through the gradual growth of the family, the race-village has been developed.

END OF VOL I

## DR. ALOIS FÜHRER'S OPINION.

BOMBAY, *February* 24, 1884.

MY DEAR DASTUR DĀRĀB,

IT is certainly a matter for congratulation that there are at the present day numerous signs showing that the attention of many of the educated Parsīs is being seriously directed to the preservation and development of Zand literature. It cannot be said, of course, that much has yet been actually done, still it is something to know that, at all events in many quarters, there is now none of that cold indifference with which the Zand literature used to be formerly looked upon We may therefore fairly hope that, in process of time, this new feeling with respect to Zand literature may lead to very substantial and tangible benefits.

Your translation from the German of Dr W Geiger's *Ostīrānische Kultur im Alterthum* is, in my judgment, one of the most important and useful of the productions to which the feeling referred to has given birth Dr Geiger's interesting volume is written with all the ease and elegance characteristic of one who is at once master of his subject and of the art of exposition and the language he employs. He writes with singular grace, so adorns whatever he handles, and so illuminates it with the most felicitous illustrations, that even his discussions on the most dry and recondite subjects flow and fascinate, as if they were vivid historical narrations. Many Parsīs will, therefore, hail with pleasure your translation of Dr. Geiger's book as a volume that is much wanted.

The literary excellence and accuracy of your translation, which I have carefully compared with the German original, will commend it to the Parsī reader as well as to the student of Irānian history, while the notes given by you will add to its importance in the eyes of scholars.

I beg to remain, my dear Dastur Dārāb,

Yours very sincerely,

A. FUHRER, Ph D.

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## DR. WM. GEIGER'S OPINION.

NEUSTADT A. H., RHEINPFALZ, GERMANY,
*February* 10, 1884

MY DEAR SIR,

. . . . Regarding your translation I can say that I was glad to observe its correctness and elegance. It is very clear and renders the meaning of the German original in a perfect manner.

Therefore I beg you to receive my cordial congratulations for having so well accomplished your work.

As I have already written, my opinion is that by the common labour of the learned Parsee priests and of the European scholars the researches into the religious books of the Zoroastrians will make the best progress and will be finished as well as possible.

I remain, my dear Sir,

Yours ever sincerely,

DR. WILH. GEIGER

To DASTUR DĀRĀB PESHOTAN,
BOMBAY

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## MR. WORDSWORTH'S OPINION

### AS EXPRESSED IN SEVERAL OF HIS LETTERS.

MAHĀBULESHWAR, *May* 18, 1884.

MY DEAR SIR,

1\. . . . . If there is a Zoroastrian public in India sufficiently intelligent to be interested in knowing what cultivated foreigners think and say of their religious history, I do not think that your labours will be thrown away. The task of translating a difficult German book into English is sufficiently arduous even for an Englishman, and must be doubly so for a native of this country. Critics will, however, bear this in mind and not be too exacting. . . .

2\. . . . . I have compared carefully six pages of your translation with the original, and think that it is very carefully executed. I did not notice any failure to convey the German writer's meaning, or any inelegancy in the English. I regret that I have not leisure to extend my review of your performance. I think the book ought to be interesting to your countrymen and other natives of India

3\. . . . . My impression, after comparing a few pages of your translation with the original text, is that you are quite qualified to undertake a work of that kind.

Yours sincerely,

W. WORDSWORTH.

To D. P. DASTUR, ESQ.

drying, the tissue loses its excess water and becomes translucent again, but if frozen whilst swollen, the fibres become broken up and disorganised.

The fat becomes rancid on prolonged storage: the change can be followed by estimating the increase in free acids and the decrease in the iodine number. The state of the fat determines the period of storage, since the slightest taint of rancidity is undesirable, and this develops whilst the lean part of the meat is still improving in flavour.

Little alteration occurs in the proteins during storage after the resolution of rigor: in a short period of hanging, autolysis is negligible, there is no increase in the water which can be expressed from the muscle, and, except on exposed surfaces where methæmoglobin may be found, no change in the pigment.

As regards the carbohydrates, the effective changes are over within 3 days of slaughter: the lactic acid reaches its maximum of about 0.8 per cent and then remains unaltered throughout storage.

With ordinary cleanliness, bacterial contamination of the carcase is only slight, and experiment showed that increase in the bacterial content of meat hung for 17 days at 41° F. is negligible.

The experiments on the palatability of the stored beef were carried out at the Household Arts Department, King's College for Women, London, and at Messrs J. Lyons and Co.'s laboratories. They showed that conditioning effects a marked improvement in palatability, particularly in respect of tenderness, but also of juiciness and texture, without any change in flavour. The improvement is more marked with coarse than with prime joints. A few experiments also indicated that freezing beef has no marked deleterious effect on its palatability.

Apart from the scientific aspects of the improvement of the meat supply, the demand of the public for good meat is an important factor to be considered, and it is to be hoped that the experimental grading and marking scheme for home-killed beef [3] will stimulate this demand by giving purchasers confidence that they can obtain exactly what they require.

### FRUIT AND VEGETABLES.

The chemical changes occurring in apples stored at 12° and 1° C. have been further studied by D. Haynes and H. K. Archbold. The rate of loss of respirable material, sugar, acid, and residue (cell wall material) per unit of nitrogen (protoplasm) has been found to be characteristic of the variety. Storage life may be roughly divided into three periods: in the first, the starch is hydrolysed with a concomitant rise in sugar; in the second, at 1° C., the total sugar and sucrose decrease, but the reducing sugar rises slowly to a maximum, in other words, the rate of inversion of sucrose is greater than the rate of consumption of its products; in the third, at 1° C., internal breakdown has set in and the rate of loss of sugar is increased; at this point the sucrose has all been inverted and the stable reducing sugars stored in the vacuole are oxidised. Throughout, acid is lost, the rate in the first and third periods being faster than in the second. At 12° C. internal breakdown does not occur but is replaced by senescence, which is observed at an earlier period of storage life and is characterised by very similar changes in the constituents of the fruit.

Fungal invasion of stored apples has been studied by A. S. Horne: a close relationship between the chemical composition of the fruit and susceptibility to invasion has been found; thus decrease in the amount of acid is associated with an increase in the rate of invasion. The relationship between growth of fungi and the environment, especially the humidity, has also been studied by R. G. Tomkins.

The possibility of the cold storage of vegetables has been investigated by J. Barker: the commoner vegetables can be stored for a few weeks at 45° or 33° F. The lower temperature is the more satisfactory, except for potatoes, which sweeten near the freezing-point. Even lower temperatures, 26° and 29° F., at which partial freezing occurs, are satisfactory for cabbages, cauliflowers, or sprouts, but not for tomatoes, cucumbers, or lettuces. Preliminary experiments on the rate of deterioration after removal from cold store indicated that 33° F. was more suitable than 45° F., except for tomatoes.

These excerpts must suffice to indicate the nature of some of the work which has been carried out under the direction of the Board. Among other subjects dealt with are corrosion of metal food-containers, with the production of hydrogen and perforation of the can, the transport of butter in insulated vans, and the freezing of fish on board the trawler so that it can be kept for a longer time and landed in a fresher condition. The report also refers to work on the control of temperature and humidity and on methods of refrigeration.

[3] Home-killed Beef: Experimental Grading and Marking Scheme. Ministry of Agriculture and Fisheries. Marketing Leaflet, Nos. 13 and 13a.

## Nickel in Engineering.

IN a lecture on "Nickel and its Uses in Engineering", delivered before the Junior Institution of Engineers on Nov. 15, Mr. W. T. Griffiths stated that, prior to the War, 65 per cent of the world's production of nickel was utilised in the manufacture of nickel steel for armament purposes; after the Armistice, production dropped to the level of the years 1890–91.

New uses for nickel have now increased the consumption to as high a figure as any attained during the War. A considerable portion of the output is used, on account of its high melting-point, in the radio electrical industry for parts of wireless valves; it is also used for the electrodes of sparking plugs. In chemical engineering much use is made of it on account of its ability to withstand alkaline reagents. In mechanical engineering it is largely used by means of electro deposition for building up worn parts of mechanisms, but its principal uses are found when alloyed with other metals; for example, in steels it increases toughness, and in conjunction with heat treatment much improves the homogeneity of castings; in case-hardened articles it increases the penetration of the hardening material, and in many cases eliminates a preliminary heating and quenching; in conjunction with chromium and molybdenum, large forgings can be made as the elastic limit of the material is much improved. In Canada, nickel alloy steel is used in casting the bar framing of locomotives and even in boiler parts including plates, firebox and tubes being made of an alloy steel containing 2 per cent of nickel, thus enabling the boiler pressure to be increased by some 37 per cent without increasing the weight of the engine.

When alloyed with iron, nickel has the property when present to the extent of about 25 per cent of destroying the magnetic properties of iron, but a higher percentage of nickel restores these properties, and the Western Electric Co. of America has established that after heat treatment of high content nickel-iron alloys, the magnetic qualities are 10-13 times better than the best soft iron; it also has much effect in diminishing the hysteresis loss. These properties are

of much use in submarine cables where great permeability is desirable to ensure quick working. The alloy is insulated from but wound round the copper conductor and prevents the interference of stray currents. An alloy of 35 per cent nickel, 35 per cent cobalt and iron, known as perminvar, shows great constancy of permeability. In heat-resisting steels, it prevents corrosion of the steel up to temperatures of 600-700° C. Nickel chromium alloys are now largely used for electrical heating purposes, ribbons of the alloy arranged along the top and sides providing the heating elements in large annealing furnaces.

Nickel alloyed with copper increases the tensile strength of the latter from 21 tons to 45 tons per square inch. It is now greatly used for condenser tubes, these as compared with brass having a long life without corrosion.

In the discussion following the paper, it was stated that nearly all the nickel used in the world comes from within the Empire, Canada producing 90 per cent of it; there are also small deposits in New Caledonia.

## University and Educational Intelligence.

BIRMINGHAM.—On Nov. 13 the new Mining Machinery Laboratory was opened by Mr. Evan Williams, president of the Mining Association of Great Britain. The object of the laboratory is to enable students of mining to get first-hand knowledge of the construction and mechanism of the latest coal-mining machinery, which will be supplementary to the knowledge of the operation of coal-cutting and conveying, which can only be learnt underground. The Miners' Welfare Fund has found the money for the building, and the machinery for equipment has been presented by the manufacturers themselves, no fewer than twenty-two firms having contributed of their products. The opening of this laboratory marks a further step in the policy of the Mining Department, which is to help the coal industry to regain its prosperity by providing it with trained public school and university men who, after acquiring experience underground, should be capable of contributing to the solution of some of the many problems with which the industry is confronted.

CAMBRIDGE.—Mr. D. Portway, St Catharine's College, has been appointed University lecturer, and Mr. G. S. Gough, Pembroke College, University demonstrator in the Faculty of Engineering.

Dr E. K. Rideal has been appointed a member of the Board of Research Studies.

MANCHESTER.—Prof. F. E. Weiss will retire at the end of the present session from the George Harrison chair of botany and the directorship of the Botanical Laboratory. He has held these appointments since 1892.

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IT it announced in the Report of the governing body of the School of Oriental Studies of the University of London that a lectureship in Iranian studies has been founded in the School. The funds for the foundation have been provided for a period of five years by the Parsee community of Bombay. This is not the first occasion on which humane and historical studies in Great Britain have been indebted to the public spirit and munificence of the Parsee community in India, and there can be little doubt that when the first period of five years has elapsed it will once more come forward to meet an increasing need. For, as the report points out, this chair is the only provision in Britain for this important branch of Oriental studies. In fact, the great increase in the study of Sanskrit and Indian history has necessitated the institution of two new lectureships in these departments.

## Calendar of Patent Records.

**November 23, 1848.**—The idea of perforating sheets of postage stamps was due to Henry Archer, who devised a machine for "cutting or stamping around the margin of every stamp a consecutive series of holes whereby the tearing up of the sheet will be greatly facilitated," and obtained an English patent for his invention on Nov. 23, 1848.

**November 24, 1854.**—In a patent granted to him on Nov. 24, 1854, Sir Henry Bessemer proposed to give rotation to a projectile when fired from a smooth-bore gun by allowing a portion of the powder gas to escape through passages formed in the projectile and terminating in the direction of a tangent to its circumference. The tangential emission of gas would then act as a turbine and produce a rapid rotatory motion of the projectile. The British military authorities refused to undertake tests of the invention, but Bessemer carried out successful experiments in his own grounds near Highgate and afterwards at Vincennes before the Emperor Napoleon III. It was the necessity of increasing the strength of the guns to enable them to withstand the resulting pressures that led Bessemer to the serious study of the metallurgy of iron.

**November 24, 1874.**—The earliest proposal for a barbed-wire fencing was made in the United States in 1867, but the most important patent was that granted to Joseph F. Glidden on Nov. 24, 1874, on an application made on October of the previous year. Glidden's application was challenged by Jacob Haish, another prominent inventor of a barbed wire, but the United States patent office decided in favour of Glidden, and it is mainly on his invention that the industry was established. Patent litigation between the rival interests was continuous from 1874 until 1892.

**November 25, 1802.**—William Dobson was granted a patent on Nov. 25, 1802, for his "new invented method never before applied for that purpose of chasing away flies and venemous insects, and calculated to promote the free circulation of air in rooms". The invention comprised a clockwork-driven fan mounted on a telescopic standard or pendant. The 'Zephyr', as it was called, was adopted by many large houses in Great Britain and abroad.

**November 26, 1822.**—Joseph Egg, a London gun-maker, who, on Nov. 26, 1822, was granted a patent for improvements in fire-arms "upon the self-priming and detonating principle", is one of the claimants to the invention of the copper percussion-cap. He appears to have been the first to manufacture such caps, but it was stated a few years later that he obtained the idea of the cap indirectly from Joshua Shaw, who probably has a better right to be called the actual inventor.

**November 29, 1879.**—The early multiple switch-boards for telephone exchanges did not completely fulfil their function, because satisfactory means had not been devised whereby any operator could instantly ascertain whether a particular subscriber's line was already engaged by another operator. The first to incorporate a practical 'test' apparatus of this kind in a telephone switchboard was the American, C. E. Scribner, who was granted a British patent on Nov. 29, 1879, for his invention. The earliest known proposal for a switchboard for the purpose of inter-communication between individual subscribers at their own request was made in connexion with the telegraph system, and was patented by François Dumont in France in 1850, also in the month of November, and in England a few months later. A few installations of this character came into use.

## Societies and Academies.

LONDON

**Royal Society,** Nov 14 —**V Henri** and **O R Howell** The structure and activation of the molecule of phosgene An analysis of the ultra-violet absorption spectrum of phosgene vapour The spectrum, about 270 bands between 3050 A and 2380 A, has been photographed at pressures from 0 1 mm up to 680 mm and analysed The absorption region is therefore the same as for all substances containing the CO group, but whereas with aldehydes and ketones the absorption reaches a maximum at about 2800 A, with phosgene it increases continuously towards the ultra-violet The spectrum is purely vibrational The bands consist of doublets with a separation of 0·5-1 A, and of singlets distributed at regular intervals in the spectrum As an aid to elucidating the ultra-violet spectrum, the Raman spectrum of phosgene was also obtained —**T M. Lowry** and **C B. Allsopp**. A photographic method of measuring refractive indices A film of liquid is formed between the half-platinised plates of a quartz etalon, illuminated with multi-chromatic light from a metallic arc, and the interference bands formed in the film focused on the slit of a spectrograph After calibrating the instrument with an air film, the refractive index of the liquid is deduced from the number of ripples between two fixed points on the slit of the spectrograph.—**C P Snow** and **E K Rideal** Infra-red investigations of molecular structure (3 and 4). The vibration-rotation band ($n''=\frac{1}{2}\rightarrow n'=\frac{1}{2}$) of CO has been resolved completely. The general character of vibration-rotation bands carried by $^1S$ molecules is discussed, and the CO bands are shown to be consistent with the scheme. A theoretical discussion includes constants of potential functions and description of band lines —**P. M. S. Blackett, P. S. H. Henry,** and **E. K. Rideal**. A flow method for comparing the specific heats of gases A slow stream of gas passes through an electrically heated iron tube, to which are attached constantan wires, in such a way as to measure temperature difference between two points symmetrically placed on tube Temperature distribution along the tube alters slightly, and, under certain conditions, measured temperature change is a direct measure of specific heat of gas.—**J. H. Brinkworth**. On the temperature variation of the specific heats of hydrogen and nitrogen. Specific heats of nitrogen can be calculated to an accuracy of 1 in 500, at 60°-1200° K, using Callendar's characteristic gas equation With a modified Planck-Einstein formula for rotational specific heat, hydrogen values agree extremely well with experiment below 600° K., at 1000° K. they are high, but there is excellent agreement at 1200°-1600° K. Moments of inertia of molecules of hydrogen and nitrogen are deduced —**R. W. Lunt** and **M. A. Govinda Rau**: The variation of the dielectric constants of some organic liquids with frequency in the range 1 to $10^3$ kilocycles. There is no variation for benzene, ether, or chloroform, but a slight increase for methylated ether, ethyl alcohol, acetone, aniline, and nitrobenzene takes place in the range $10^2$-$10^3$ kc. In this range the conductivity of aniline diminishes rapidly as the frequency is increased, that of nitrobenzene diminishes slightly, whilst that of ethyl alcohol and of acetone does not vary.—**J. A. Hall**: The international temperature scale between 0° and 100° C. An extensive intercomparison between the platinum-resistance thermometer and a number of mercury in *verre dur* thermometers, standardised by the Bureau International des Poids et Mesures, shows that the change from the latter to the former as the standard of the National Physical Laboratory, will not alter the temperature scale used by that institution by more than 0 002° C. between 0° and 50 C. or 0·005° C. between 50° and 100° C. Differences between scale defined by platinum thermometer and thermodynamic scale probably do not exceed a few thousandths of a degree between 0° and 50° C., or 0 01 C between 50° and 100° C —**D M Murray-Rust** and **Sir Harold Hartley** The dissociation of acids in methyl and ethyl alcohol. In methyl and ethyl alcohols, HCl, $HClO_4$, $HClO_3$, $HEtSO_4$, $HSO_3C_6H_5$ are strong electrolytes, while $HNO_3$, HCNS, $HIO_3$ are weak acids From measurements with hydrogen chloride, the mobility of the hydrion is calculated to be 142 in methyl, and 59 5 in ethyl alcohol Addition of small quantities of water to solutions of acids in alcohol causes large decrease of conductivity of the strong acids and correspondingly large increase in case of weak acids, and can be used as a qualitative test for the two classes —**K. S Krishnan**. The influence of molecular form and anisotropy on the refractivity and dielectric behaviour of liquids The theory of the optical and electrical properties of liquids outlined by Raman and Krishnan is applied to the case of benzene for which the necessary data are available The change in the Lorentz refraction 'constant' in passing from vapour to liquid, and the effect of temperature and pressure variations on the 'constant' are successfully evaluated numerically. The application of the theory to the dielectric behaviour of liquid benzene is equally successful.

**Linnean Society,** Nov 7.—**Dr Hugh Scott**: A natural history excursion into Basutoland. Deforestation and destruction of big game have been extensive. Almost the only native 'timber' seen was scrub composed of a Rosaceous bush, *Leucosidea sericea*, 5-15 ft high All arable land is devoted to cultivation of mealies (maize) and Kafir corn (*Sorghum*), and the grassy slopes are stocked with horses and cattle Entomological collecting resolves itself largely into 'sweeping' grass and flowers, searching under stones and working the low dense bush of kloofs The insects obtained, about a thousand specimens, are being dealt with at the British Museum A species of cockroach was observed to display maternal care for its young, a fact of considerable biological interest. —**G. E Nicholls**: A new Syncaridan from the west coast of Tasmania This small freshwater crustacean was first taken by the author in February 1928 in a sphagnum-choked ditch near Queenstown. It is the third member of the sub-order Anaspidacea to be discovered in Tasmania, and seems most closely related to *Koonunga cursor*, at present known only from the Australian mainland. It is less than one-third of an inch in length, colourless and almost transparent The mature animal is conspicuous by its golden or orange-coloured gonads, and in these specimens a chocolate-brown pigment is developed irregularly upon the dorsal surface

EDINBURGH.

**Royal Society,** Nov. 4 —**Frances M. Ballantyne**: Notes on the development of *Callichthys littoralis* A description of the embryonic and larval stages of this armoured Siluroid. After giving a general account of the ontogeny of the fish, the development and the adult form of the skull and chondrocranium, of the fins and external skeleton, and of the various organs, are described in some detail. Particular attention is directed to the air-sacs at either side of the head, and their relationship with the otocyst, and it is shown that they develop from a transient air-bladder.

These very specialised fish have some primitive characters reminiscent of *Polypterus* and the Dipnoi The resemblance to *Polypterus* is specially marked in the development of the paired fins and in some of the modifications of the venous blood-system, while another primitive feature is shown in the platybasic chondrocranium where the trabeculæ are continuous with the parachordals The facts of development, however, clearly show that the Siluridæ are rightly placed among the Teleostei —**A W Greenwood**: Some observations on the thymus gland in the fowl. The examination of thymus weights in normal, castrated, and gonad engrafted fowls showed that in normal adult fowls the thymus is larger in the male than in the female Castration and ovariotomy delay or decrease the rate of thymus involution Whereas successful implantation of testis into complete males has no effect on the thymus, successful implantation of ovary causes a degree of thymus involution comparable with that in the female — **B. P Wiesner**: On the mechanism of the diphasic sex cycle. The periodic appearance of the œstrous cycle is due to periodic secretion of the ovary. There exists periods of refractory behaviour in the ovarian response to anterior lobe. The anterior lobe itself works periodically in two phases: the first phase incites the first phase of ovarian secretion (œstrous hormone) through an œstrogenic substance (Rho 1); the second phase incites beta production in the ovary through a 'kuogenic' substance (Rho 2). Methods are described for the separation of Rho 2, which is more resistant to heat than Rho 1, and the specific test for it (mucification) is discussed —**L. Mirskaja**: On the presence of a kuogenic substance in the mouse placenta. The placenta, when implanted in the immature mouse, creates conditions of pseudo-pregnancy, and never induces œstrus Since it is without effect in the ovariectomised female, it is assumed that it contains a kuogenic substance equivalent to Rho 2 from the anterior lobe —**A C. Fraser and B. P. Wiesner**: Variations of the rest metabolism of the rat in relation to the sex cycle Varies considerably in relation to the œstrous cycle. A relatively high maximum is reached shortly after heat.— **H. W. Turnbull and J. Williamson**: Further invariant theory of two quadratics in *n* variables. The paper materially simplifies an original argument used twenty years ago, which was the basis of a paper published by the Society in 1925.

### PARIS.

Academy of Sciences, Oct. 14.—**Marin Molliard**: Two new examples of morphological characters depending upon external conditions. The abnormal development of hair in a pea pod can be produced by partially exposing the internal epidermis of the pod to the air. The second case was the experimental production of red stripes in the petals of the white opium poppy by prematurely opening the buds and separating the two sepals —**Léon Guillet and Ballay**: The corrosion of aluminium alloys in superheated steam. The experiments were carried out on the purest aluminium obtainable (99·87 per cent), three samples of ordinary commercial aluminium, an alloy with 8 per cent copper, duralmin, and alpax. The purest metal was completely destroyed; alpax was the most resistant to the steam. It is probable that the corrosion in steam is a function, not only of the chemical composition, but also of the structure and previous thermal and mechanical treatment of the alloy. — **Herbrand**: The fundamental problem of mathematics.—**J. A. Lappo-Danilevski** The generalisation of the formula of Jacobi concerning the determinant formed from solutions of a system of linear differential equations —**A. Andronow** The limit cycles of Poincaré and the theory of self-maintained oscillations —**A Tsortsis** A method of integration of Monge's equations.—**Victor Vâlcovici** The generalisation of the theorem of moments of quantities of motion.—**N. Théodoresco** A formula generalising Cauchy's integral and on the equations of plane elasticity.—**André Argand**. Concerning the study of the plane irrotational movement of incompressible fluids in the steady state.— **Marcel Prot**. The calculation of railway sleepers of reinforced concrete —**William Loth** The magnetic guidance of airships; safety aerodromes Description of improvements on the method described in 1921 and 1922 for guiding aeroplanes or airships to an aerodrome under conditions of bad visibility —**Maurice Lambrey**. The absorption spectra of nitric oxide —**P. Chevenard**. The limit of the solubility of copper in the reversible ferro-nickels. An application of the dilatometric method to the study of the diagram iron-γ-nickel-copper —**Paul Remy-Cennetė**: The dissociation of calcium hydride, $CaH_2$ Previous work on this subject has given discordant results, some workers have found normal dissociation phenomena, others suppose that the hydride and the metal form a continuous series of solid solutions, and that the pressures found are a function of the calcium in excess. In the present experiments, the distillation of the calcium is prevented by enclosing it in a sealed iron tube, advantage being taken of the fact that at high temperatures iron allows hydrogen to pass through, but not calcium vapour. It has been established that the pressure is a function of the temperature only and is independent of the proportion of calcium present —**B Bogitch** The oxidation and reduction of the iron silicates by gases. A blue silicate exists corresponding to a lower oxide of iron which alone is stable in the presence of metallic iron at high temperatures This lower oxide is nearly always accompanied by FeO — **Maurice François** Study of the dissociation of the compounds $HgBr_2 . 2NH_3$ and $HgCl_2 . 2NH_3$. These compounds are molecular combinations analogous with Isambert's ammoniacal silver chloride —**A. Pereira Forjaz**: Contribution to the study of the Muntz methods of nitrification. In the biochemistry of the fixation of atmospheric nitrogen it is possible that mineral catalysts may intervene; experiments with *Cytisus proliferus*, var. *palmensis* using a spectroscopic method showed that in this case the specific elements of biocatalysis were molybdenum, nickel, and cobalt.— **L. Mercier**: The chetotaxy of the wing of *Limosina pusilla*, from the point of view of secondary sexual characters.—**Brocq-Rousseu, Mme. Z. Gruzewska, and G. Roussel**: The influence of the ionic concentration of the medium on the activity of the amylase of horse serum. Whatever number of successive bleedings may be carried out, amylase and maltase are always found in the serum. Diagrams are given showing the relation between the sugar present and the number of bleedings.—**Paul Génaud**: The ion exchanges between yeast cells and solutions of lead nitrate.—**A. Policard, S. Doubrow, and M. Boucharlat**: The mechanism of pulmonary silicosis. The influence on cells cultivated *in vitro* of silica dusts arising from working on the rock in coal mines. Gye and Kettle, in their studies on silicosis, and Mavrogordato, in experiments on the effects of dust inhalation, have attributed this action to the slow solubility of silica in the slightly alkaline tissues. The experimental facts cited tend to confirm the view that regards the origin of the troubles of pulmonary silicosis as due to a slow toxic action of slowly dissolved silica.—**Georges Blanc and J. Caminopetros**: Some experimental data

on the virus of dengue The experiments described show that the virus of dengue and that of yellow fever are distinct

VIENNA

Academy of Sciences, July 11 —**E Gebauer-Fulnegg** and **E Riess** The course of oxidation in aryl-sulpho-arylides —**E Reiss** and **R Feiks** The action of aromatic sulpho-chlorides on $\beta$-amino-anthraquinone —**E Blumenstock-Halward** and **E Riess** Note on trimercapto-$\beta$-naphthol.—**M. Samec** Sulphurylisation of starch —**E Abel** and **E Neusser** The vapour pressure of nitrous acid —**O. Redlich** The molecular state of water.—**F Bock** and **G. Lock** The determination of hydroquinone and pyrocatechin in the presence of other phenols (1) —**K. Beaucourt** The constituents of resin (1). The boswellinic acid from olibanum (incense resin) —**F. Pollak**. The kinetics of the reaction between bromic acid and hydrobromic acid.—**K. Schwarz**. A simple micro-method for determining molecular weights Depends on isothermic distillation.—**G. Koller** and **E. Krakauer** The constitution of cetraric acid, $C_{20}H_{18}O_9$, obtained from an Icelandic lichen.—**G. Koller** and **E. Strang** Some derivatives of 6, 7-benzo-1, 8-naphthyridine —**W. Leithe**. The natural rotation of polarised light by optically active bases (4) The rotation of some synthetic isoquinoline derivatives —**H. Holter** and **H. Bretschneider**: Researches on the possibility of the formation of tetrazomethane, $CN_4$ —**G. Burger** The separation of alkalis in minerals with the interferometer A possible gravimetric determination of potassium and sodium by an optical method —**A. Friedrich** and **A Salzberger** On lignin (5) The connexion between lignin and resin. The resin in spruce wood differs from the resin obtained from wounds of this tree, the resin extracted from the wood containing methoxyl groups. There is one sort of lignin dissolved in the wood-resin and another lignin in contact with cellulose —**H. Mache**: Specific heat on the lines of equal internal energy and of equal heat content.—**J Kisser**. Analysis of the results of chemical stimuli in seed germination Preliminary inquiries with quickly germinating seeds Access of oxygen is of great importance.—**J Kisser** and **S. Possnig**: Researches on the influence of impeded and promoted oxygen respiration on seed germination and seed growth Oxygen helps, the seed-coat of *Pisum* hinders access of oxygen, hydrogen peroxide penetrates the seed-shell.—**J. Kisser** and **R. Stasser**. Researches on the bending of roots and hypocotyls of shelled seeds of Leguminosæ. The seed-coat adheres to the radicle, hence removal of this part of the coat may injure the radicle.—**J. Kisser** and **R Windischbauer**: Researches on the permeability of the seed coats of *Pisum sativum* for water and gases Hydrogen peroxide delays the swelling, but stimulates germination. Weak solutions of sodium and manganese chlorides promote swelling of the seed-coat. Air-dry seed-coats permit the passage of gases with difficulty.—**S. Meyer**: Physical foundations for radium emanation therapy. Radium emanation absorbed by the human body is in preponderating measure lost again by breathing.—**E. Kara-Michailova** and **B. Karlik**: The relative brightness of scintillations of H-rays of different range. The $\alpha$-particles lose energy in penetrating a crystal layer, and the brightness corresponds to the energy lost Effects depend on the size of the crystals and the thickness of the zinc sulphide layer.—**K. Fritsch**. *Camelina rumelica*. A variable plant.—**E. Müller** and **W. Loerpabel**: The catalytic decomposition of aqueous solutions of formic acid by the platinum metals (4).—**R. Schumann**: Vectorial adjustment of a measured triangle.

## Official Publications Received.

BRITISH

Transactions of the Institution of Chemical Engineers Vol 6, 1928 Pp 202 (London )

Commonwealth of Australia Bureau of Meteorology Results of Rainfall Observations made in Western Australia including all available Annual Rainfall Totals from 1374 Stations for all Years of Record up to 1927, with Maps and Diagrams, and Record of Notable Meteorological Events, also Appendices, presenting Monthly and Yearly Meteorological Elements of Perth, Broome and Kalgoorlie Pp xiv+387 (Melbourne H J Green )

Studies from the Connaught Laboratories, University of Toronto Vol 3 1926-1928 Pp vii+331 (Toronto University of Toronto Press )

Department of the Interior, Canada Publications of the Dominion Observatory Ottawa Vol 10 Bibliography of Seismology No 1, January February March 1929 By Ernest A Hodgson Pp 17 (Ottawa F A Acland )

Records of the Geological Survey of India Vol 62, Part 2 Pp 187-201+9 plates (Calcutta Government of India Central Publication Branch ) 2 12 rupees 5s

Proceedings of the Sixteenth Indian Science Congress, Madras, 1929 (Third Circuit ) Pp xxxiv+474 (Calcutta Asiatic Society of Bengal )

Home Office Report on Conferences between Employers, Operatives and Inspectors concerning Fencing of Machinery, First Aid and other Safeguards in Cotton Weaving Factories By Eliot I May Pp 21 (London H M Stationery Office ) *3d* net

FOREIGN

University of California Publications in American Archaeology and Ethnology Vol 24, No 2 Petroglyphs of California and adjoining States By Julian H Steward Pp 47-238+plates 22-94 2.50 dollars Vol 24, No 3 Yokuts and Western Mono Pottery-making By A H Gayton Pp 239-272+plates 95-102 40 cents Vol 25 No 4 Archaeology of the Northern San Joaquin Valley By W Egbert Schenck and Elmer J Dawson Pp 289-413+plates 74-102 1.75 dollars (Berkeley, Cal University of California Press, London Cambridge University Press )

Conseil International de Recherches, Union Geodesique et Geophysique Internationale Section d'Oceanographie Bulletin N 12 Bibliographie des Marees (1910-1927) By Prof J Proudman Pp 27 (Venezia )

Recueil des Travaux Chimiques des Pays-Bas Publie par la Societe Chimique Neerlandaise Tome 48, No 9 Pp 797-1074+ii (Amsterdam D B Centen )

Publications de l'Observatoire Astronomique de l'Universite de Belgrade Tome 2 Annuaire pour l'an 1930 Redige par V V Michkovitch Pp 133 (Belgrade )

CATALOGUES

High Tension Transformers for the Production of X Rays (Bulletin W ) Pp 48 (London Watson and Sons (Electro-Medical) Ltd )

Chemische, chemisch-technische und physikalische Zeitschriften (Jahrg 8, Nr 4, November ) Pp 16 (Berlin Verlag Chemie, G m b H )

Catalogue of Important, and in many cases, Rare Books in various Branches of Natural History (No 172 ) Pp. 96 (London Dulau and Co, Ltd )

Medical Books, New and Second-hand (Catalogue of Dept. No 9, November ) Pp 44 (London W and G Foyle, Ltd )

The Bureau of Information on Nickel Nickel Steel, Series A, Paper No 4 Breaking Records and Breaking Stresses, Nickel Alloy Steels in the *Golden Arrow* Pp 8 (London The Mond Nickel Co, Ltd )

## Diary of Societies.

*FRIDAY*, NOVEMBER 22

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botany Department, Imperial College of Science and Technology), at 2 30 —Research on Infestation of Stored Products (a) Entomological—(i) Survey and Inspection Work, W S. Thomson, (ii) Biological Work, G V B Herford, (b) Mycological, R H Bunting

ANDERSONIAN CHEMICAL SOCIETY (at Royal Technical College, Glasgow), at 8 15 —A. L Parker Artificial Silk

PHYSICAL SOCIETY (at Imperial College of Science), at 5 —D P Dalzell: Heaviside's Operational Methods —E T Hanson The Dynamical Theory of Resonators —E C Atkinson. Escapement Errors of Pendulum Clocks

INSTITUTION OF ENGINEERING INSPECTION (at Royal Society of Arts), at 5 30 —T. W Willis: Saws Their Manufacture and some Hints on their Use.

BRITISH PSYCHOLOGICAL SOCIETY (Æsthetics Section) (at Bedford College), at 5 30 —J M Thorburn. Spengler's Æsthetic.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6 —H. W Rowell Commercial Synthetic Resin Products

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7 —J. S Atkinson and others The Utilisation of Low-Grade and Refuse Fuels, including Towns' Refuse

JUNIOR INSTITUTION OF ENGINEERS, at 7 30 —H D Bush. The Quick-Running Oil Engine applied to and used in Railway Service

ROYAL SOCIETY OF MEDICINE (Epidemiology and Tropical Diseases Sections), at 8 —Discussion on Brucella Infections in Man and Animals Openers Dr W Dalrymple-Champneys (Epidemiology), Dr J T Duncan (Tropical)

ROYAL AERONAUTICAL SOCIETY (Yeovil Branch) (at Yeovil) —Aero Wheels and Tyres.

*SATURDAY*, NOVEMBER 23

BRITISH MYCOLOGICAL SOCIETY (at University College), at 11 A M —Prof R R Gates and D A Daran Zygospore Formation in *Mucor* —Miss J Grove Growth Reactions of *Helotium scutula* Karst —Dr R G Tomkins The Relation of Mould Growth to Humidity —Dr H Wormald Some Recent Observations on Brown Rot Diseases of Fruit Trees —E C B Wright Sexual Reproduction in *Penicillium*

*MONDAY*, NOVEMBER 25

INSTITUTE OF ACTUARIES, at 5 —H J Tappenden A Valuation of Non Participating Policies without Classification

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7 —C Wade and others Discussion on Wooden Poles for Overhead Transmission Lines, and their Preservation

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7 30 —W H Goddard The Mercedes Benz Diesel Engine

BRADFORD TEXTILE SOCIETY (at Midland Hotel, Bradford), at 7 30 —P Morgan Welsh Wools

ROYAL SOCIETY OF ARTS, at 8 —Dr E G Richardson Wind Instruments from Musical and Scientific Aspects (Cantor Lectures) (II )

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8 —J H Badcock The Design of Partial Dentures Considered in Relation to the Health of the Oral Tissues —F St J Steadman A Dentigerous Cyst in Connexion with a Supernumerary Incisor —Dr E W Fish A Report on Dr Gottlieb's Histological Study of the Results of Traumatic Occlusion

MEDICAL SOCIETY OF LONDON, at 8 30 —Clinical Evening

*TUESDAY*, NOVEMBER 26

INSTITUTE OF MARINE ENGINEERS, at 6 30 —A F Evans The Origin and Development of Heavy Oil Engines

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub Centre) (at University College, Nottingham), at 6 45 —E H Smythe and E G Weeks Low-Temperature Carbonisation of Fuel, with Special Reference to its Combination with the Production of Electricity

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle upon-Tyne), at 7 —Capt P. P Eckersley Broadcasting by Electric Waves (Faraday Lecture)

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7 —Lt Col S E Monkhouse and L. C Grant · Heating of Buildings Electrically by Means of Thermal Storage

INSTITUTE OF METALS (Birmingham Local Section) (jointly with Birmingham Metallurgical Society and Staffordshire Iron and Steel Institute) (at Chamber of Commerce, Birmingham), at 7 —G W Woolliscroft The Modern Development of the Steam Locomotive

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7 —Dr S O Rawling How it works in Photography A Chemist's Notions about Sensitivity (Lecture)

INSTITUTION OF AUTOMOBILE ENGINEERS (Western Graduates' Section) (at Works of Bristol Tramways and Carriage Company, Ltd , Brislington, Bristol), at 7 30 —E W Sisman Braking Topics

WEST KENT SCIENTIFIC SOCIETY (at Wesleyan Hall, Blackheath), at 8 30.

*WEDNESDAY*, NOVEMBER 27.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section), at 5 —J Menton and H W Steele Bodger The Improvement in the Public Milk Supply Is Pasteurisation Necessary?

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (North-Western District) (at Manchester Town Hall), at 6 —Parliamentary Bill Proceedings

INSTITUTION OF AUTOMOBILE ENGINEERS (Manchester Centre) (at Engineers' Club, Manchester), at 7 —F R Banks The High-Speed, Compression-Ignition, Heavy Oil Engine

SOCIETY OF CHEMICAL INDUSTRY (Newcastle Section) (at Armstrong College, Newcastle-upon Tyne), at 7 30 —W S Coates Modern Boiler Practice (II ) Boiler Feed Water Conditioning

TEXTILE INSTITUTE (Lancashire Section) (at Art School, Macclesfield), at 7 30 —A J Hall · The Physical and Chemical Properties of Cellulose in Relation to Technical Treatment of Cotton and Artificial Silk.

SOCIETY OF DYERS AND COLOURISTS (Midlands Section) (at Globe Hotel, Leicester) (jointly with Foreman Dyers' Guild), at 7 45 —F. Willis and W A Edwards A Short Résumé of the Manufacture of Hosiery Goods with Special Reference to Difficulties met with in Dyeing and Finishing

ROYAL SOCIETY OF ARTS, at 8 —C N Kemp The Examination of Coal and Coke by X-Rays (Dr Mann Lecture)

INSTITUTION OF CHEMICAL ENGINEERS (at Chemical Society), at 8 —J Strachan. Production and Treatment of Cellulose in the Paper Industry

*THURSDAY*, NOVEMBER 28

IMPERIAL COLLEGE CHEMICAL SOCIETY (at Royal College of Science), at 5 —Prof H. V A Briscoe · The Work of the Coke Research Committee (Lecture)

CHILD STUDY SOCIETY (at Royal Sanitary Institute), at 6 —Miss Marion Richardson The Teaching of Handwriting

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—H. W. Taylor Voltage Control of Large Alternators

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle upon-Tyne), at 6 —G S Baker Wake

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6 30 —Squadron Leader H. M Probyn Flying and Maintenance from the Owner's Point of View.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group —Informal Meeting), at 7 —A S Newman The Care and Upkeep of Amateur Kinema Apparatus.

INSTITUTION OF AUTOMOBILE ENGINEERS (Luton Graduates' Section) (at Royal Hotel, Luton), at 7 30 —S W. Dixon. The Automobile Compression Ignition Engine.

INSTITUTION OF AUTOMOBILE ENGINEERS (Newcastle upon Tyne Centre) (at Y M C A , Newcastle upon Tyne), at 8 —A Healey The Pneumatic Tyre in Heavy Transport

MEDICO LEGAL SOCIETY (at 11 Chandos Street, W 1), at 8 30 —F Llewellyn Jones The League of Nations and the International Control of Dangerous Drugs

INSTITUTION OF MECHANICAL ENGINEERS (Cardiff Branch) —Prof H L Callendar Critical Relations between Water and Steam (Thomas Hawksley Lecture)

*FRIDAY*, NOVEMBER 29

INSTITUTION OF MECHANICAL ENGINEERS, at 6 —R H Parsons and others Debate on The Registration of Reliable Tests of Power Plant Machinery

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7 30 —W C Freeman Modern Welding Systems and Applications

LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemistry Section) (jointly with Leicester Association of Engineers) (at College of Technology, Leicester), at 7 30 —Dr J N Friend Science in Antiquity

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Graduates' Section) (at 51 West Regent Street, Glasgow), at 8 —J W Robertson Two stroke Engines Some Experiments on a New Type

*SATURDAY*, NOVEMBER 30

ROYAL SOCIETY, at 4 —Anniversary Meeting

## PUBLIC LECTURES.

*FRIDAY*, NOVEMBER 22

KING'S COLLEGE (at 40 Torrington Square, W C 1), at 5 30 —Dr O Odlozilik Outlines of Czechoslovak History (I ) The Geography of Czechoslovakia

SURVEYORS' INSTITUTION, at 5 30 —Dr A W Hill Kew and its Relation to Botanical Enterprise in the Empire (Institution of Professional Civil Servants' Lecture)

ROYAL SOCIETY OF ARTS, at 8 15 —Prof A E Boycott The Causes of Cancer (Chadwick Lecture)

*SATURDAY*, NOVEMBER 23

HORNIMAN MUSEUM (Forest Hill), at 3 30 —Miss I D. Thornley Village Life in the Middle Ages

*MONDAY*, NOVEMBER 25

UNIVERSITY COLLEGE, at 2 —Prof H Spencer Medicine in the Days of Shakespeare

LONDON SCHOOL OF ECONOMICS, at 4 30 —E H Warmington The Debt of Medieval Explorers to Ancient Discoverers The Exploration of Inner Africa

UNIVERSITY OF LEEDS, at 5 15 —Dr F W Aston Atomic Masses

SCHOOL OF ORIENTAL STUDIES, at 5 30 —Dr W R Rickmers The Alai—Pamirs—a Geographical Background of Oriental Studies (Succeeding Lectures on Nov 26 and 28 )

*TUESDAY*, NOVEMBER 26.

UNIVERSITY OF LEEDS, at 5 —Prof M J Stewart Disease

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Manchester) —Dr G C Simpson Past Climates (Alexander Pedler Lecture of the British Science Guild)

*WEDNESDAY*, NOVEMBER 27

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4 —Prof S L Cummins · Some Aspects of the Tuberculosis Problem

SCHOOL OF ORIENTAL STUDIES, at 5 15 —A Lloyd-James Accent as an Element in Speech

KING'S COLLEGE, at 5 30 —Prof R R Gates The Contribution of King's College to the Advancement of Learning during the Century 1829-1928. The Sciences of Life

UNIVERSITY COLLEGE, at 5 30.—L McColvin Some Aspects of the Future of Public Library Work

INSTITUTION OF ELECTRICAL ENGINEERS, at 5 30 —Dr C H. Lander Physics in Relation to the Utilisation of Fuel (Institute of Physics Lecture)

NORTHAMPTON POLYTECHNIC INSTITUTE, at 7 —Dr H J Gough The Strength of Metals in the Light of Modern Research (Armourers and Brasiers' Company Lectures) (I ) (Succeeding Lectures on Dec 4 and 11 )

*FRIDAY*, NOVEMBER 29

COLLEGE OF MEDICINE (Newcastle-upon Tyne), at 8 —Prof. A E. Boycott · The Causes of Cancer (Chadwick Lecture).

*SATURDAY*, NOVEMBER 30

HORNIMAN MUSEUM (Forest Hill), at 3 30.—H. N Milligan · The Hydra in Fact and Fiction.

## CONGRESS.

NOVEMBER 22 AND 23.

PUBLIC WORKS, ROADS, AND TRANSPORT CONGRESS (at Royal Agricultural Hall)

*Friday, Nov* 22, at 11 A M —B. P Davies: Economical and other Considerations in connexion with Roads and Bridges —H P H. Morgan Practical Points to be considered in the Improvement and Widening of Main Roads

At 3 —W J. Jones · The Application of Electricity to Roads from the Point of View of Street Lighting and Traffic Signalling —J [illegible] Smith Reflections on the Purposes and Scope of Agricultural Education —Capt G. A Wright: Land Drainage

*Saturday, Nov.* 23, at 11 A.M —R Beveridge · Costing as an [illegible] Economy.

SATURDAY, NOVEMBER 30, 1929.

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*Editorial and Publishing Offices*

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No. 3135, Vol. 124]

## Native Education in Africa.

IN no part of the British Empire is the task of developing education services more difficult, onerous, and important than in British territories in Africa. In the Union of South Africa, the task is complicated by the language differences between the British, Dutch, immigrant Asiatics, and indigenous peoples, the different social customs and religions of the white, brown, and black elements, and the economic differences based upon the differing standards of living between these three distinct racial types. The situation in East Africa and parts of British Central Africa is much the same. In British West African territories, if we except the Cameroons, there is no white or Asiatic problem, but a complication exists because of an essential difference between the ideals underlying British colonial policy and those of the French and Belgians whose colonial territories are adjacent.

In his recent Rhodes Memorial Lecture at Oxford on "Native Policy in Africa", General Smuts pointed out that British colonial policy is enshrined in the Covenant of the League of Nations. Art. 22 of the Covenant lays down that to those colonies and territories taken from the Powers defeated in the War, which are inhabited by peoples not yet able to stand by themselves under the strenuous conditions of the modern world, there shall be applied the principle that the well-being and development of such peoples form a sacred trust of civilisation, and that this trust shall be carried out by the advanced nations. "The well-being and development of peoples not yet able to stand by themselves", says General Smuts, "can only mean the progress and civilisation of these backward peoples in accordance with their own institutions, customs, and ideas, in so far as these are not incompatible with the ideals of civilisation."

This is the ideal. It is one upon which education policy must be based in the British Colonial Empire, not only in the territories which the British administer under mandate from the League of Nations—and Great Britain, the Union of South Africa, Australia, and New Zealand, each have such mandates—but also in those territories for which we have been responsible for varying lengthy periods of years. In India for more than a century we have been attempting, however imperfectly, to put this ideal into practice. In West Africa, in Mauritius, in British Malaya, in the Sudan, our efforts have been in the same direction. Rhodes's conception of our responsibilities in Africa was substantially in harmony with the principle of

trusteeship white settlement to supply the steel framework and the stimulus for an enduring civilisation, and indigenous native institutions to express the specifically African character of the natives in their future development and civilisation "

That the education of the natives of South Africa has only recently been developed in consonance with Rhodes's ideals has been due to the prejudices and short-sighted economic dogmas of the white settled populations They attempt to justify their attitude by asserting that the native peoples can profit only by primary education, that they reach a phase of mental stupidity or 'saturation' by the time they are adolescent. The intellectual successes of American West African negroes, and even the recent successes of South African Bantus at the South African College and the universities of Great Britain, leave many, we are almost tempted to say the majority of, Europeans in Africa, unconvinced that the native peoples are not inherently generally intellectually inferior The consequence has been that, until quite recently, practically the whole responsibility for the education of the native peoples in South, West, and East Africa has been left to the various missionary bodies In South Africa, although the native pays, in proportion to his means, much higher taxation than the white man, the amount spent on the education of the whites is many times the amount spent on five times the number of natives. Wherever there is a white settled population in our African Crown Colonies, the position is similar.

Fortunately, not even the active hostility of the majority of white settled peoples in Africa, South or East, has been able to withstand the explicit enunciation by the European powers of the principle of trusteeship with all its implications The governments of the Union of South Africa, of Southern Rhodesia, of British West and East African colonies are now definitely committed to the provision of educational facilities for the African peoples, either directly by the creation of government educational institutions or indirectly by financial grants-in-aid to and government supervision of missionary schools and colleges, and a real start has been made. Since 1916 there has been a Native College in South Africa at which Bantu students can read for university degrees In West Africa there are several institutions which take native students up to the standard of the entrance examination for universities in Great Britain or America —and there is every hope that before very long Achimota College on the Gold Coast will attain to the status of a university institution. At Makerere in Uganda a similar government institution has been created, one which already trains Africans for professional occupations, in addition to which Uganda boasts of several missionary institutions where the standard of education provided is above that of our matriculation. Nyasaland also provides, in many missionary centres, an advanced type of education for the natives In Tanganyika the government has taken the lead in providing for the higher education needs of the native population, and in Kenya the training college for Jeanes (or itinerant) native teachers appears likely to exert a far-reaching influence upon the educational progress of the peoples of that country

Southern Rhodesia, which enjoys a large measure of self-government, established a separate Department of Native Education at the beginning of 1928 under the direction of Mr H Jowitt His first report,[1] which he presented to his legislative council recently, is worthy of careful study by those interested in African problems Native education, considered as a government-aided system, covers a quarter of a century in Southern Rhodesia In that period the number of grant-earning schools has increased from four to approximately 1600 · the grants have increased from £105 to approximately £40,000. The schools are classified under three heads first-class schools are boarding schools under European supervision, following a prescribed code, including at least two hours industrial work a day, and with actual instruction by a European teacher on a reasonable number of days a year; a second-class school is a day-school under a European teacher, who must give instruction on a reasonable number of days during the year; and a third-class school is the ordinary kraal school where pupils are taught to read and write in a native language, with the elements of writing and arithmetic, for at least two hours a day. There are two government native schools which are not classified.

Altogether, about 2500 teachers, 270 of whom are Europeans, are engaged in the work of dealing with a school population of about 100,000. The classified schools are all the result of missionary effort, twelve distinct Christian missionary bodies having established schools in the colony. A large number of their schools have now been inspected by the officers of the new Department and the report throws an interesting light on their efficiency. The kraal schools are staffed for the most part by ex-scholars who have received no training for their

[1] Southern Rhodesia. Report of the Director of Native Education for the Year 1928 Pp 48. (Salisbury Government Printer, 1929.)

work other than that provided by the primary school which they attended. Their standard of knowledge of school subjects is rarely above that of a boy or girl aged eleven or twelve in Great Britain. Their main work is to enable the pupils to gain sufficient knowledge to become Church members. Chief stress is laid on vernacular reading, particularly in relation to relevant portions of Scripture which must be mastered before the candidate can become a member of the Church. They are supervised by missionary superintendents, most of whom labour under the disadvantage of lack of knowledge of teaching technique and organisation of schools. The Inspector of Native Schools, Salisbury, in his first report to the Department, says, "I have on record at least 12 superintendents who are unacquainted with the Native language".

As the Director of Native Education remarks, it would serve no useful purpose to attempt a meticulous survey of the present curricula in the missionary schools. He has inherited a medley of schools in various stages of growth, staffed for the most part by uneducated, unknowledgeable men and women, badly paid, inadequate to their duties and responsibilities, muddling along without proper guidance and without proper buildings or materials. The facilities for training of teachers have been practically non-existent. "It can be stated without fear of contradiction that professional training, in the common acceptation of that term, hardly existed in most of these [training] centres before 1928."

This picture of the state of native education in Southern Rhodesia is by no means unique in Africa. There are other British Crown Colonies where the conditions are much the same.

Nevertheless, the future is promising. A tremendous effort is now being made in every part of British Africa to improve the educational standards of the native peoples. There is opposition to overcome, it is true, but most colonies have now a Department of Native Education. Most of the directors are men of courage, able, like Mr. Jowitt, to express clearly and forcefully the underlying social aims of an education system and its requirements, and possessing his faith that most of the native peoples of Africa are educable up to a very high standard. A properly organised system of education for the native peoples of Africa is the first requisite to the building up in Africa of a people able to enter into co-operative partnership with the Europeans in the task of developing the immense natural resources of a mighty continent.

## Origin of Coral Reefs.

*The Coral Reef Problem.* By Prof. William Morris Davis. (American Geographical Society Special Publication No. 9.) Pp. viii+596+16 plates. (New York: American Geographical Society, 1928.) 6 dollars.

In 1913 Prof. W. M. Davis began to investigate the controversial subject of the origin of coral reefs. Since that time he has written numerous papers, and travelled many thousands of miles to see reefs for himself. This present volume incorporates the material of those papers and voyages, and enables those interested in coral reefs to obtain his views conveniently.

The appearance of this book is an event of considerable importance in geographical literature. Most writers on coral problems have been biologists, with the result that speculations on the origins of the different types of reefs have been somewhat varied and often have had but slight reference to the fundamental teachings of geology and physiography. It is not intended in any way to ignore or belittle the great importance of the biological study of reefs: far from it. But it is questionable how far a study of reef features and details is able to throw any light on to the origin of the reef as a whole. Looked at as an entity, a reef must clearly bear a close relation to the island or mainland which it borders, and if a reasonable interpretation is to be made of its origin, the physiographical characteristics of the shoreline must receive careful consideration. If, on the other hand, we are dealing with atolls, little direct evidence of their origin can be obtained from them. But, by deduction, we may draw certain conclusions about atolls from a study of elevated reefs or barrier reefs of other areas. In fact, the greatest difficulty of the whole coral problem is the origin of atolls; and a final answer to it can probably only be given when, if ever, we have a large number of deep borings made through characteristic atoll-reefs. Meanwhile, geographers, geologists, geophysicists, and biologists are able to help in solving this mystery by deduction until such borings are made.

It is, then, in the stress laid upon the physiographical and geological side of the problem that Davis has made such an important contribution to the already voluminous literature on the subject. Whatever criticisms may be passed on the book, it must be admitted, frankly and sincerely, by all who are interested in coral reefs, that Davis has succeeded in throwing much new light on the

problems awaiting solution, and in focusing attention on an aspect of the subject which had been sadly neglected The interesting fact which stands out so clearly from Davis's work is that we are brought back once again to Darwin's views on the origin of reefs, which were first expressed more than eighty years ago Since then numerous other theories have appeared, all of which have, directly or indirectly, made some contribution to the problem, but their main characteristic has been that they did not agree with the subsidence theory of Darwin and Dana. Davis, after reviewing these theories, and applying his deductive methods to the study of reefs both in the field and from charts, finds much evidence for reverting, with one or two minor modifications, to the Darwin-Dana hypothesis.

The only theory which Davis considers is a serious rival to the Darwin-Dana theory is the glacial control theory of Daly. It is not relevant to review here the merits of this theory, but it is important to appreciate that much of the future work on reef origins will probably involve fluctuations of sea-level and oscillations of sea temperature in the glacial period The locking up of water in the great ice-caps appears to be an accepted fact: but we have still much to learn about the ice age, and if, as Depéret and others suggest, we have to deal with not one, but several fluctuations of sea-level in recent times, the coral problem may take on an even more complicated aspect than it has at present Further, if we are to assume subsidence —often of great magnitude—we must consider seriously how such movements can occur. Is it enough, in other words, to assume that such subsidence has taken place because deductions drawn from a study of reefs lead us to think so? Must we not review the evidence in the light of recent geophysical work on the earth's outer shell?

The book is divided into two parts and contains an excellent bibliography The first part deals with the leading theories of coral reefs: the theories are stated and criticisms advanced. The second, and by far the larger, part of the volume is devoted to the study of the facts of the problem. It is rather difficult to read this second part: so many points are reviewed and so many cases cited, that to assess adequately the real value of the subject matter necessitates either a visit to critical areas, or, at least, a careful study of large-scale charts. Nevertheless, the facts are marshalled in a masterly way, and much convincing evidence is brought together to show that Darwin's views are often better able to explain the known phenomena of various types of reefs than are those of any other worker

On the other hand, one cannot avoid the feeling that, at times, Davis has allowed deduction to play too big a rôle in the matter, even though he himself admits, in such cases, the theoretical nature of his reasoning For example, the explanation of certain features observable in the Fiji Islands is related to a moving anticline, so that, as the anticline passes, reefs alternately rise and fall. Or, again, in his account of the Great Barrier Reefs of Australia, Davis bases much of his evidence on some work of Andrews in northern New South Wales Andrews there postulated a three-cycle development, which, Davis suggests, may also possibly apply to the Great Barrier Reefs Quite apart from the fact that Andrews later modified his views, and so undermined the possibility of such an application, it does seem rather unnecessary even to try to extend a process of evolution relative to a region well to the south of the Barrier, to the reef area itself, which extends over one thousand miles Deduction may be carried too far.

The volume contains an admirable and brilliant review of the coral problem, and the deductions of the author are usually clear and incisive But there is yet much to learn about coral reefs, and the honest doubter may be excused if he asks for yet more definite knowledge about particular reefs and views somewhat critically the circumstantial evidence that Davis presents in favour of a complete acceptance of Darwin's views.

J A STEERS.

## The "Index Kewensis".

*Index Kewensis Plantarum Phanerogamarum. Supplementum septimum nomina et synonyma omnium generum et specierum ab initio anni MDCCCCXXI usque ad finem anni MDCCCCXXV nonnulla etiam antea edita complectens* Ductu et consilio A W. Hill. Confecerunt Herbarii Horti Regii Botanici Kewensis Curatores Pp iii+260 (Oxford: Clarendon Press; London. Oxford University Press, 1929.) 75*s*. net.

THE monumental "Index Kewensis" and its successive supplements are recognised as an indispensable part of the equipment of any important botanical institution, affording as they do a ready means of reference to the names, the first places of publication, and geographical distribution of all the known genera and species of flowering

plants published from the year 1753 down to the present day In works of this character, the prompt appearance of the successive issues is of great importance, and it is therefore highly gratifying that new arrangements, mentioned in the preface, have made it possible to publish the seventh Supplement, which covers the period 1921–25, only three years after the appearance of the sixth, which covered the preceding quinquennium, 1916–20

It may not be out of place to mention here a few of the many ways in which the Index is of service If any question arises as to the correct or original way of spelling of a botanical name, the original spelling can be obtained from the Index, though obvious errors are of course corrected. Those interested in horticulture or economic botany may find out the native countries of the plants with which they are dealing and verify the names by means of comparison with the original descriptions cited in the Index To the research worker in the systematic botany of the flowering plants, the Index, and especially its supplements, are absolutely indispensable, in view of the widely scattered nature of the literature in illustration of this fact, it may be mentioned that about four hundred different periodicals were examined during the preparation of the present Supplement.

As each successive Supplement has been prepared, it has been the aim of those responsible to adopt any practicable modifications which would increase the general usefulness of the Index without altering its format. From the third Supplement onwards, lists of addenda, which were found to be very troublesome to consult, have been omitted, any new or corrected entries being inserted in the next issue. From the fourth Supplement, the dates of publication, so important for purposes of priority, have been inserted in all cases. The geographical information supplied is now much more detailed, the precise country or province being stated wherever practicable. Where new names are based on previously published ones, the latter are cited so that the connexion between the two names may be apparent.

A novel and invaluable feature incorporated in the present Supplement is a separate list of new genera, arranged under their families. This enables a botanist who is interested in one particular family, such as Orchidaceæ, for example, to see at a glance what new genera belonging to this family are contained in the supplement, information which is unobtainable from other sources without a prohibitive expenditure of time.

The present Supplement contains 260 pages, as compared with 222 in Supplement VI., the increase being due partly to the increased activity of botanical research during the period, and partly to the inclusion of many references which had been generally overlooked owing to their having been published in obscure periodicals or books. As regards the general style and typography, it may suffice to say that the present volume worthily upholds the high traditions of the Clarendon Press.

We are glad to see that Supplement VII. has been published only three years after the appearance of Supplement VI The War naturally caused a delay in the appearance of Supplements V and VI, but now, thanks to a special assistant (Miss M. L Green) having been added to the Herbarium staff to supervise the laborious work of preparing the Index, the progress of the work has been considerably expedited We notice in the preface that during the past twenty-two years the work of supervising the preparation of the Index has been entrusted to Dr. T. A. Sprague, who has carried out the work with great ability.

## Sir Thomas Clifford Allbutt.

*The Right Honourable Sir Thomas Clifford Allbutt, K.C B* A Memoir by Sir Humphry Davy Rolleston, Bart. Pp vii + 314 + 3 plates. (London: Macmillan and Co, Ltd, 1929.) 15s net.

It is fitting that Sir Humphry Rolleston should write a memoir of Sir Clifford Allbutt, his immediate predecessor in the chair of physic at Cambridge Sir Humphry was closely associated with him in the great "System of Medicine", which has become a classic, and is near akin in his mental equipment both professionally and in his wide outlook. The memoir is so easy to read that only a close scrutiny shows how great has been the pains taken to get the facts accurately, to verify the references, and to maintain a due sense of proportion. All this Sir Humphry has done to perfection, and has succeeded in presenting a charming portrait of a learned physician who was also a cultured gentleman.

Born in 1836, a Yorkshireman, the son of the vicar of Dewsbury, Clifford Allbutt knew Charlotte Bronte and had seen Emily. He was thus able, in later life, to give a clear presentation of the position of the Brontës and to dispel the myths which were beginning to form round this remarkable family. As the son of a north-country vicar, he was not overburdened with wealth, but a classical scholarship defrayed the cost of his education at Caius College, Cambridge, from 1855. He decided,

however, to read science instead of classics, and took his degree after obtaining a first class in the Natural Sciences Tripos, gaining distinction in chemistry and geology. By this time he had shown some literary ability, had thought of becoming an artist, and had interested himself in music The necessity of earning his living turned his attention to medicine. He entered St. George's Hospital, qualified, and settled in practice at Leeds, devoting himself from the beginning to medicine, and keeping himself during the lean years by writing for both lay and professional reviews.

Sir Humphry has taken Allbutt's life year by year, and elucidates his work by a running commentary which illustrates the main facts of a busy life with clearness and precision. First, the strenuous period (1861–1889), when as a physician he built up so great a consulting practice that he was nearly overwhelmed and accepted a commissionership in lunacy (1889–1892) as a relief. Lastly, the years (1892–1925), when he was Regius professor of physic in the University of Cambridge, a dignified post in which he found full scope for his many activities. During a portion of this last period, the similar post at Oxford was held by an equally remarkable man—Sir William Osler. Both were outstanding in their generation; in many points their characters agreed, in many they differed: Allbutt, a great English gentleman with the culture and something of the outlook of the older physicians, his thought based upon classical models, Osler a great humanist, with a wide knowledge of men gained in all parts of the world, one who looked forward rather than backward, versatile in all things, the founder of a school, endowed with an impish spirit he could not always restrain, which would have been quite foreign to Allbutt. Both were great teachers and brought to their classes an extensive knowledge of disease gained at the bedside. Both served their generation by writing text-books of world renown, so that their knowledge was not confined to the limited few who came into personal relationships with them. Both were absolutely honest in word and in deed, and both desired to advance professional knowledge by a wider education of the medical student, Allbutt by linking up human with animal pathology, Osler by improving historical knowledge and inculcating a love of the great masters in medicine and surgery

These resemblances and these differences Sir Humphry brings out to admiration, and thus presents a picture of Allbutt as a leader of the medical profession. Incidentally, he shows how recent is the use of the clinical thermometer Wunderlich, the second edition of whose book "On the Temperature in Disease" was translated in 1871, used a thermometer nearly a foot long and left it in the patient's armpit for twenty to twenty-five minutes. Allbutt, in 1867, had a short clinical thermometer made It measured six inches in length, cost 7*s.* 6*d.* in a case, and recorded the temperature in five minutes. The length of the instrument was afterwards reduced to three inches, an index was supplied, Fahrenheit's scale was employed instead of the Centigrade, which would have been better, and by 1876 it was becoming standardised.

The book is illustrated with two portraits of Clifford Allbutt, which his friends will recognise as excellent likenesses, and there is a remarkably satisfactory index.

## Heat Engines.

*Steam and other Engines.* By J Duncan. Revised and enlarged edition. Pp. xi + 536. (London: Macmillan and Co., Ltd, 1929) 6*s.*

IT has been very difficult during the last few years to recommend a text-book to the beginner in the study of heat engines, but it may be said that this new edition, containing as it does a treatment of the reciprocating steam engine, steam turbine, and internal combustion engine, has almost solved the difficulty. Entropy, total heat-entropy diagrams, and the mathematical treatment of steam turbines, are usually intended for advanced students, and to some extent their inclusion renders the book a little advanced for the first year man, while, on the other hand, the second year student will certainly find the treatment given rather insufficient. It would have been preferable to omit such semi-advanced matter and devote a special chapter to the study of condensers and air-pumps instead of using only four pages, and these mainly concerned with the marine condenser, for this important section of heat engineering.

Considerable additions have been made both in subject matter and illustrations, and these have been treated in the light of modern engineering practice. The chapter on the properties of steam calls for special comment. Here the author has added to his charts, so as to cover the higher pressures and temperatures now met with in large steam plants, and a valuable feature is the diagram showing the variations of specific heat of superheated steam at constant pressure with temperature and pressure. It is regrettable, however, that approximate formulæ should have been quoted for

liquid heat of water and specific volume of superheated steam, when the former can be read directly from Callendar's steam tables and the latter be calculated from the rational formulæ, also included in his tables

It is surprising how many modern writers dealing with the action of steam in the cycles of a reciprocating engine still adhere to the old theory that initial condensation is almost exclusively responsible for all the losses, although it has been repeatedly shown by eminent authorities that this is not the case. The author is not altogether exempt from this criticism, despite the fact that 'leakage' is mentioned in a small paragraph.

The chapters on internal combustion engines form a welcome addition. The matter is well developed and the illustrations are numerous and well chosen, especially those dealing with the heavy oil engines, which are all of modern design. This part of the book, together with the description of a high-pressure marine steam plant, should prove of great interest to all engineering students.

The descriptive matter is very clearly developed throughout the book, indicative of the author's experience of good teaching practice, and the new edition can be said to be a distinct acquisition to a student's bookshelves.

## Our Bookshelf.

*Geology of Gold (South Africa, Australia, New Zealand).* By E. J Dunn. Pp. x+303+163 plates. (London: Charles Griffin and Co., Ltd., 1929.) 35*s.* net.

THIS treatise is founded on the author's personal experience in South Africa, Australia, and New Zealand In the first-named country he spent many years, from about 1872 to 1886, when he left for Australia. His knowledge of the geology of these countries, especially in regard to the occurrence of gold, is perhaps unique. It is not quite up-to-date in regard to South Africa; although in the early days Dunn was a pioneer in South African geology, having given the first description of the Pretoria Series under the name of Lydenburg Beds, and the name of Dwyka to the famous glacial conglomerate.

The book contains much material founded on the author's observations in mines he has reported on; and his notes and diagrams are of considerable interest in connexion with ore genesis. In twenty-two chapters, the first of which is an introductory description of the earth's crust, he deals with country rocks, fissures, faults, lodes, dykes, veins, indicators, conglomerate reefs, walls of lodes, sources of gold, solubility of gold, secondary deposition of gold, metasomatic gold, minerals associated with gold occurrence, the forms of lode and alluvial gold respectively, the distribution of lode and alluvial gold, deep leads, high-level leads, and gold in glacial deposits A special chapter is devoted to a description of the famous Mount Morgan mine in Queensland, which, from its inception to the end of June 1926, yielded 5,305,979 ounces of gold and 139,427 tons of copper, of the aggregate value of £29,739,276 This chapter is of especial interest, as the author had an opportunity of studying the secondary enriched ore, which is a feature of the Mount Morgan mine On the occasion of the author's first visit, the daily yield from this ore amounted to 1000 ounces of gold Exact surveys were made by the author while yet the mine was in a youthful stage, and at intervals, until the last of the secondary ore was removed In this way a record was secured, and a complete suite of samples collected, which in the end was presented to the Victorian Mines Department.

Special attention is given by the author to the occurrence of alluvial gold, from which the bulk of the gold production of Australia has been derived, and the author's photomicrographs of the different forms of alluvial gold are of great interest and invaluable for reference and comparison. There are 250 photomicrographs, of which 60 are of alluvial gold and the remainder of lode gold and country rocks. The 172 diagrams (plans and sections) illustrate the occurrence of lodes and veins, faults, dykes, saddle-reefs (Bendigo, Victoria), indicators, auriferous conglomerates (Transvaal), and alluvial deposits.

F. H. HATCH.

*The Nautical Almanac and Astronomical Ephemeris for the Year 1931 for the Meridian of the Royal Observatory at Greenwich* Standard edition. Pp. vii+865. (London: H.M. Stationery office, 1929) Paper, 5*s.* net; cloth, 7*s* net.

THIS issue marks an epoch in the history of the "Nautical Almanac"; it is the first drastic revision of its general arrangement since 1834. All elements that were formerly given for Greenwich mean noon are now given for mean midnight; also, all the data referring to the sun are grouped together, and the same is done for the moon. The rectangular co-ordinates of the sun are given for midnight only, but first and second differences are printed, also auxiliary interpolation tables. The co-ordinates are given both for the equinox of 1950·0 and for that of 1931·0. It is desired to encourage the use of the 1950 equinox, and tables are given for reducing observed positions to this equinox.

For the convenience of users of calculating machines, both natural and logarithmic values of the sun's radius vector, Besselian day numbers, etc., are given. Much fuller information than before is given relating to the satellites of the planets. These include satellites VI. and VII. of Jupiter, but not VIII. or IX.; it is to be hoped that they may be included in the future. The list of observatories has been revised and extended. The inclusion of Uranibourg among "Former observatories" will be welcomed. The table of Julian days has been expanded, and now includes day 0 of each month from 1850 to 1940; outside these limits there are reduction tables, which diminish the risk of error.

There are two interesting essays in the volume, that on the calendar is by Dr J K Fotheringham, and it gives full details both of ancient and modern calendars We learn that Ptolemy Euergetes anticipated Julius Cæsar in 238 B C in trying to introduce a leap day every fourth year; but the attempt remained unsuccessful until two centuries later. The other essay is on time, and contains the statement that in the 1933 Almanac the short-period nutation terms will be included in sidereal time, which will be given to the third decimal of a second. This is in recognition of the great improvement in clocks in recent years, as a result of which it is considered desirable to be able to obtain mean sidereal time, freed from nutation.

Dr Cowell ascribes much of the credit of the improvements in the Almanac to the deputy superintendent, Dr. L. J. Comrie.

*The Earth and its History: a Text-book of Geology.* By Prof. J. H. Bradley, Jr. Pp vii + 414. (Boston, New York, Chicago and London: Ginn and Co, Ltd, 1928.) 12*s*. 6*d*. net.

This book is "written for the general student who desires to be intelligent about the earth", but as a guide with that laudable object it cannot be regarded as wholly satisfactory. It is written in a vigorous and picturesque style, and is copiously illustrated with many excellent illustrations. Unfortunately, the author appears to have lost touch with modern advances in geology The treatment of isostasy is feeble. The views of T C Chamberlin dominate in the discussion of cosmogony and orogenesis, and it is suggested that the belief in a formerly molten earth is fast losing its popularity. This is not the reviewer's experience. The account of the age of the earth is very inadequate, for the author has clearly not yet liberated himself from the former prejudice in favour of a '100 million year' earth. He is sceptical of the validity of radioactive methods—for no good reasons—but compromises with a chart showing 225 million years for the Cambrian and 500 million years for the oldest Archæozoic. Such a compromise is highly unscientific, for there is no evidence whatsoever, and never has been, supporting figures of this order. One would expect a new book on geology to refer to the investigations carried out under the auspices of the Carnegie Institution in the field of vulcanology, but here there is no mention of any such recent work. Despite its attractive features, the book cannot be regarded as other than old-fashioned in its treatment of current problems.

*Radium Treatment of Cancer.* By Stanford Cade. Pp. x + 158 + 13 plates. (London: J. and A. Churchill, 1929.) 15*s*.

The author states in the preface that in this book he has tried to illustrate the technique of radium in cancer in various anatomical situations and some of the results obtained by it by quoting selected cases. After a few short chapters on radioactivity, the methods of irradiation and the general principles of radium therapy, the author describes, often with the aid of coloured plates, the surgical methods at present in vogue in the treatment of cancer by means of radium.

The book will probably prove of much interest to surgeons who require detailed information of this character. They may have some difficulty in the section on p. 6, devoted to units, as some of the statements require correction. The author says that the principle underlying modern radium therapy is that of prolonged irradiation with small doses. It might reasonably be objected that the main principles underlying this therapy are of a much more general character than one aspect of the time factor

The book is well produced, and some of the coloured plates give good impressions of the local effects which can be got by means of radium inserted into the tissues.

*Field Book of North American Mammals: Descriptions of every Mammal known north of the Rio Grande, together with Brief Accounts of Habits, Geographical Ranges, etc* By H. E. Anthony. (Putnam's Nature Field Books) Pp. xxv + 625 + 48 plates (New York and London: G P Putnam's Sons, 1928) 15*s*. net.

In this convenient volume, which the field naturalist can without grumble slip into his holiday baggage, or on occasion into his pocket, are described 1445 species and subspecies of mammals—the full complement of the American continent north of the Rio Grande. It is a masterpiece of condensation, discussing in detail the habits and characters of at least one prominent species in each group, and stating geographical ranges and external characters sufficiently to guide the layman in almost every case to the identity of even related species and subspecies The task of identification is lightened by 32 plates, each containing from two to thirteen excellent coloured figures, by abundance of lively and characteristic pen drawings and photographs, and by maps illustrating the distribution of geographical races. The author has produced a model of what a field-book ought to be

*List of the Vertebrated Animals exhibited in the Gardens of the Zoological Society of London, 1828–1927.* Centenary edition in 3 volumes. Vol 1: *Mammals.* By Major S. S. Flower. Pp. ix + 419. (London. Zoological Society of London, 1929.) 25*s*.

During the hundred years of its existence the London Zoological Gardens have exhibited no fewer than 949 species of mammals, representing probably most of the forms ever likely to be seen in captivity. This systematically arranged list, however, is much more than a historical catalogue of zoo exhibits. It is a valuable work of reference, giving the standard scientific name of each species, references to the original description and to a figure where such exists, synonyms, and not least interesting, the popular, local, or trade name. The first and last of these items ought to make for the standardisation of popular and scientific names in the exhibits of museum collections, where a lack of uniformity in different institutions tends to confuse the ordinary visitor.

## Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Continents and Oceans.

EVER since Wegener published in 1915 his remarkable theory of the drift of the continents and the movement of the poles, most of us have viewed a map of the world with entirely different eyes, and it has become almost instinctive to look for correspondences between the outlines of the continents and relationships between the continents and the oceans.

In this short note I wish to comment on three or four of these relationships which have struck me in my own contemplation of the subject. I imagine that they have all been noticed before, but I do not remember seeing any discussion of them.

A thing which has struck me over and over again is the symmetry of the present distribution of land and sea with reference to the present position of the earth's axis. The north polar ocean is almost circular in shape and the pole is practically at the centre of the circle. Antarctica is a circular continent and the south pole is at its centre. The great land masses of the northern hemisphere send out protuberances towards the south which, roughly speaking, all extend to the same latitude, leaving a belt of ocean encircling the globe between latitude 40° S. and 70° S., which can truthfully be described as being symmetrical about the earth's axis.

These three examples of symmetry are clear and striking, but there is another example which, although less striking, appears to me to be of equal importance, and that is the orientation of the land masses themselves in relation to the earth's axis. If my reader will open an atlas at the map of the world on Mercator's projection, he will, I think, notice the following points. In the first place, the continents appear to be standing upright. This appearance is largely due to the north-south trend of the main peninsulas, but there is much more in it than that. The main continental masses appear to have been placed in the rectangular network of the Mercator projection in the most symmetrical way possible. The best way to explain what I mean is to consider the one continent which is abnormal. South America does not 'look straight'. One feels that it is necessary to give it an anti-clockwise twist to get it right. Looking now at North America, one does not have that feeling, it already looks straight; while Australia is itself almost rectangular with sides parallel to the network. Africa is quite upright, and when one considers the whole block of Africa, Europe, Asia, and Australia, one feels that in any different orientation it would not fit the framework of the Mercator chart. I find it impossible to put this in a more concise form or to express the symmetry in mathematical language; but every one who will take the trouble to look at the map will see what I mean. That the land masses are symmetrical to the network of a Mercator chart simply means that they are symmetrical to the earth's axis, thus I feel justified in considering this good evidence of the symmetrical arrangement of the present distribution of land and sea.

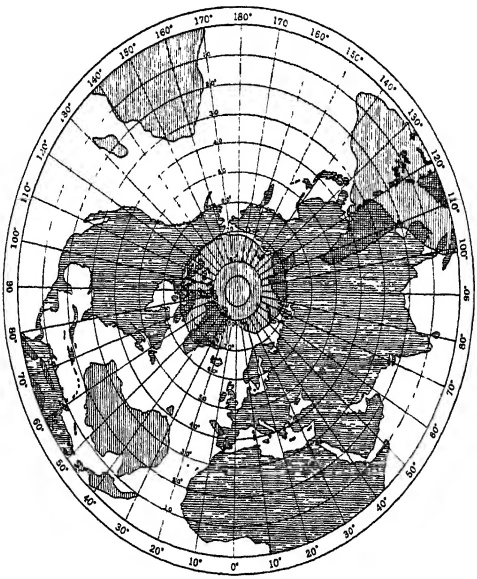

FIG. 1.

There is another characteristic of the present distribution of land and sea to which I personally have never seen any reference, namely, that, with one small exception, all the continents have oceans for their antipodes. That this might be expected to a large extent follows from the fact that the land masses are largely concentrated in one hemisphere, but I do not think many realise how completely the relationship is carried out in detail.

In Fig. 1 the distribution of land and sea in the two hemispheres is represented in such a way that every point in the northern hemisphere has its antipode superposed upon it. The land of the northern hemisphere is indicated by horizontal hatching, and the land of the southern hemisphere by vertical hatching. In the southern hemisphere there are four large land masses and it will be seen that three of these fall completely free of the continental blocks of the northern hemisphere, and the way in which Antarctica and Australia find oceans to fit them is almost uncanny. The southern part of South America is the only continental land of the southern hemisphere which has a continent as its antipode in the northern hemisphere: Is it significant that this is the only continent which we felt was not symmetrical to the earth's axis and required twisting to bring it straight, a twist which, it may be mentioned, would bring it clear of its Asiatic antipode?

The relationships which I have indicated may be entirely fortuitous or they may have a deep significance. I do not wish to discuss here which is the more probable, but I cannot help remarking that the chances against so many indications of symmetry being merely accidental must be very large. On the other hand, if they are not fortuitous but indicate some tendency to symmetrical distribution, that tendency must always have existed, and must be taken into account when discussing shifts of the pole. I do not wish these remarks to be considered to be evidence against the Wegener theory, for I feel more strongly than ever that only by a shift of the continents can the climates of other geological ages be explained.

G. C. SIMPSON.

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### Raman Spectra in Atmospheres Surrounding Metallic Arcs.

THE spectrum of the mercury arc in an atmosphere of carbon dioxide at a pressure of 6 cm. of mercury contains two faint lines coinciding in position with the two Raman lines recorded by Rasetti (NATURE, Feb. 9, 1929). Our spectrogram was taken in connexion with a study of the spectrum of the mercury arc (Fig. 1)

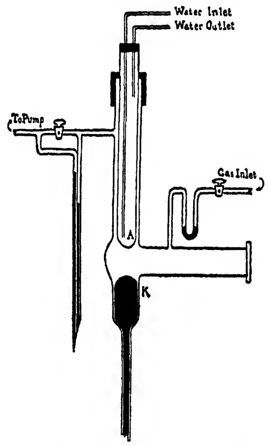


FIG 1—*A*, Water cooled anode, *K*, mercury cathode.

in atmospheres of foreign gases (*Indian Jour. Phys.* iv. 2, pp. 179-193; 1929):

| Exciting Line | | Raman Line | | | $d\nu$ | Rasetti's Value. |
|---|---|---|---|---|---|---|
| $\lambda$. | $\nu$. | $\lambda$. | (Int.) | $\nu$. | | |
| 2536 | 39413 | 2622 | (1) | 38124 | 1289 | 1284 ± 10 |
| | | 2628 | (1) | 38034 | 1379 | 1392 ± 10 |

That these faint lines are Raman lines of carbon dioxide is supported by the fact that they disappear when carbon dioxode is pumped out and do not reappear on the introduction of hydrogen. Other bright ultra-violet lines also show the corresponding Raman lines, which, however, are fainter than the above. This observation suggests a method of producing the Raman spectra of gases by running the exciting arc in an atmosphere of the gas An attempt to obtain the Raman lines of carbon tetrachloride in the visible region by running a mercury arc in an atmosphere of carbon tetrachloride vapour was inconclusive on account of the complex band spectra occurring in the region.

Our results with carbon dioxide suggest a possible origin of at least some of the faint unclassified lines observed in all spectra We have tested this hypothesis in the case of zinc and mercury, using Coblentz and Geer's extreme infra-red emission frequencies of mercury and zinc given in Kayser's "Handbuch der Spectroscopie", believing that they are molecular in origin. In the arc the formation of molecules, even in the case of monatomic vapours, is favoured by the presence of excited atoms. We find that in a considerable number of cases there are faint lines of intensity 1 or 2 corresponding to the calculated values. Moreover, nearly all these lines are marked nebulous, as an example may be mentioned the nebulous mercury line at 2687.

| Exciting Line | | Raman Line | | | $d\nu$ | Observed Infra-red Frequency. |
|---|---|---|---|---|---|---|
| $\lambda$ | $\nu$. | $\lambda$ | (Int) | $\nu$. | | |
| 2536 | 39413 | 2686·67 | (1) | 37209 | 2204 | 2206 (4·53 $\mu$) |

The above Raman line disappears when the arc is cooled (Fig. 2), a fact easily explained as due to the reduction in the concentration of the scattering molecular centres. Some of the faint lines of as yet unknown origin in the spectra of many celestial bodies

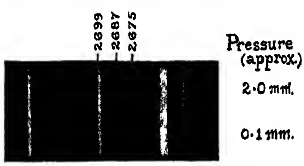


FIG 2

may turn out to be Raman lines produced in this manner. Allen (NATURE, Jan 26, 1929) has given reasons for believing that certain faint lines in the secondary spectrum of hydrogen have a similar origin, the exciting radiation being the first few lines of the Balmer series Kothari (NATURE, July 20, 1929) has adduced reasons for believing that the faint Fraunhofer lines are probably due to similar excitation and subsequent absorption, in the chromosphere of the sun.

A paper giving details will be published elsewhere.

B. VENKATESACHAR.
L. SIBAIYA.

Department of Physics,
Central College, Bangalore,
Oct. 24.

### Norman Lockyer and the Total Solar Eclipse of 1875.

MAY I, for the sake of historical accuracy, beg leave to comment on two conflicting passages in the recently published volume, "The Life and Work of Sir Norman Lockyer", both referring to the total solar eclipse of 1875.

On page 82 it is stated that in Siam, clouds covered

the sun at the time of totality, and that the failure to obtain observations was disastrous from Lockyer's point of view. But in another place, page 245, it is, on the contrary, remarked that Lockyer found strong support for his dissociation hypothesis in the results of the 1875 eclipse observations.

A brief statement of the facts relating to this eclipse may serve to remove the confusion to which these conflicting passages may give rise.

The Committee of the Royal Society which organised the expedition decided to divide it into two sections, one of which was to proceed to Siam, while the other was to establish itself in Camorta, one of the Nicobar islands. When it appeared that Lockyer could not leave England at the time, owing to other duties, I was appointed head of the whole expedition so long as it remained united, while Meldola was to be leader of the Camorta section after their separation. It was this latter division that met with bad weather, the sky in Siam being cloudless. The results of the expedition were worked out jointly by Lockyer and myself and were published in the *Transactions of the Royal Society* (1878, Part 1). The photographs showed the calcium lines H and K, as well as some hydrogen lines at the base of the corona, but no other metallic lines.

ARTHUR SCHUSTER.

Yeldall,
Twyford, Berks.

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SIR ARTHUR SCHUSTER's letter gives interesting information about the 1875 eclipse, which the biography of Sir Norman Lockyer (for the relevant portions of which I am responsible) might well have included. It is not made clear there that the British expedition divided into two sections: apparently I assumed that Camorta was in Siam!

I have no reason to think, however, that there is any material inaccuracy in the passages referred to, although I have not now access to the papers before me when writing. Certainly the passages are not conflicting. The first states that Meldola, who was Lockyer's regular assistant, had a special programme of work arranged for him; that the expedition was fruitless through clouds, although other parties were better favoured; and that the misfortune was disastrous for Lockyer, who was left to develop his ideas without the guidance of observation at a crucial point. The second passage states that he found strong support for his ideas in the results of the eclipse observations.

It is evident that observations might support existing ideas without giving guidance for future development—which is just what occurred in this instance. What Sir Arthur Schuster makes clear, and is not stated in the biography, is that the better favoured other parties included a section of the British expedition.

HERBERT DINGLE.

Imperial College of Science and Technology,
Nov. 16.

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## Combustion of Acetylene.

IN NATURE of Nov. 16, p. 761, Messrs. G. B. Kistiakowsky and S. Lenher announce that they have recently demonstrated that "The oxidation of acetylene by oxygen proceeds at 250°-315° through the stages of glyoxal, formaldehyde, formic acid, carbon dioxide, and water" according to the scheme:

$$\text{“}\left.\begin{array}{l}\mathrm{CHO}\\ \;|\\ \mathrm{CHO}\end{array}\right\}\begin{array}{l}\rightarrow \mathrm{CO+HCHO}\xrightarrow{O_2}\mathrm{H.COOH}\xrightarrow{O_2}\mathrm{CO_2+H_2O}\\ \\ \rightarrow 2\mathrm{CO+H_2} \qquad\qquad\qquad\qquad\quad \searrow \mathrm{CO+H_2O}\text{”}\end{array}$$

and that "All these reaction products have been isolated".

So long ago as 1905, in a paper entitled "The Combustion of Acetylene", by Mr. G. W. Andrew and myself (*Jour. Chem. Soc.*, 87, pp. 1232-1248) embodying the results of a detailed experimental study of the subject, and particularly of the interaction between 250° and 350° of various mixtures of acetylene and oxygen in the ratios 2 : 1, 1 : 1, 2 : 3, 1 : 2, and 1 : 3 respectively—in the course of which polyglycolide $(C_2H_2O_2)_n$ had been detected, and both formaldehyde and formic acid isolated and identified—the following statements summarising the matter appeared: "Experiments on the slow combustion of acetylene prove that carbon monoxide and formaldehyde simultaneously arise at an early stage of the process, probably as the result of the decomposition of an unstable product $C_2H_2O_2$, such, for example, as $\begin{matrix}\mathrm{C.OH}\\ \mathrm{C.OH}\end{matrix}$. The production of formaldehyde certainly precedes that of steam. The whole process may, we think, be represented by the following scheme:

$$\begin{matrix}\mathrm{C\,H}\\ \mathrm{C\,H}\end{matrix}\rightarrow \underbrace{\left[\begin{matrix}\mathrm{C.OH}\\ \mathrm{C.OH}\end{matrix}\right]}_{\substack{(2\mathrm{CO}+\mathrm{H_2})\\ 1}} \rightarrow \mathrm{CO}+\underbrace{\begin{matrix}\mathrm{H.C{\cdot}O}\\ \mathrm{H}\end{matrix}}_{\substack{\mathrm{CO+H_2}\\ 2}} \rightarrow \underbrace{\begin{matrix}\mathrm{HO.C\;O}\\ \mathrm{H}\end{matrix}}_{\substack{\mathrm{CO+H_2O}\\ 3}}\rightarrow\underbrace{\begin{matrix}\mathrm{HO.C.O}\\ \mathrm{OH}\end{matrix}}_{\substack{\mathrm{CO_2+H_2O}\\ 4}}$$

Below the ignition point the formic and carbonic acids produced at stages 3 and 4, respectively, break down, forming steam and oxides of carbon, whilst above the ignition point the formaldehyde produced at stage 2 (or possibly also the dihydroxyacetylene at stage 1) is resolved into carbon monoxide and hydrogen," and further, that "the initial stage of the combustion involves the formation of an oxygenated molecule $C_2H_2O_2$ . . . which rapidly breaks down to carbon monoxide and formaldehyde, the last-named product being subsequently burnt, through formic and carbonic acids, to a mixture of CO, $CO_2$ and steam".

It was also found that "there is little to choose between the rates of combustion observed with mixtures corresponding to $2C_2H_2 + O_2$ and $C_2H_2 + O_2$, respectively, below the ignition point. An excess of oxgyen over and above an equimolecular proportion always retards the process."

While the recent experiments of Messrs. Kistiakowsky and Lenher have led them to adopt practically the same view regarding the mechanism of the combustion as we published twenty-four years ago, the results of our then experiments can scarcely be reconciled with their statement that "in packed vessels . . . a heterogeneous oxidation direct to carbon dioxide and water takes place". We found that, on continuously circulating a $C_2H_2 + 3O_2$ mixture in a closed circuit comprising (i) a combustion tube packed with porous porcelain maintained at 380° and (ii) apparatus for removing both condensable and water soluble products, 96·1 of acetylene burnt gave rise to 84·9 carbon dioxide, 74·7 carbon monoxide, 32·6 formaldehyde, 58·6 steam, and 4·6 hydrogen, reckoning all products as gaseous and occupying the same volume at the same temperature. From this it was deduced that of the total formaldehyde theoretically formed at stage 2 of the combustion, 4·8 per cent had decomposed into carbon monoxide and hydrogen, 33·9 per cent had appeared unchanged in the products, while the remaining 61·3 per cent had been further burnt, through formic and carbonic acids, to oxides of carbon and steam.

One outstanding feature of the explosive combustion of acetylene to which we then directed attention, and which distinguishes its case from that of ethylene, is

that *on explosion with less than its own volume of oxygen*, no steam formation (indicative of the thermal decomposition of monohydroxy-acetylene) can be observed. In such circumstances, half the acetylene is burnt through $C_2H_2O_2$ to $2CO + H_2$, the other half being resolved by the heat into its elements together with a small amount of methane I therefore agree that, in the combustion of acetylene, unlike that of ethylene and of other hydrocarbons, so far there is no evidence of a primary monohydroxy-stage, the initial stage apparently involving the direct formation of an oxygenated $C_2H_2O_2$ molecule. WILLIAM A. BONE.

Imperial College of Science and Technology,
London, S.W.7, Nov 18.

### High Temperature Allotropes of Manganese.

IN a communication entitled "A High-Temperature Modification of Manganese" (NATURE, Aug. 31, 1929) Messrs. Persson and Öhman confirmed, by means of the X-ray examination of the lattice structure of a series of copper-manganese alloys, the existence of the allotropic transformation of manganese which I had previously found to take place at 1191° ± 3° C. and showed that its structure corresponded with that of the tetragonal modification, as determined by Westgren, of manganese obtained by electrolysis. They also found that the critical point 1024° ± 3° C., on the other hand, did not seem to be accompanied by any change of crystal structure.


FIG. 1—Microstructure of manganese after heat treatment at various temperatures and quenching in water ×100 *A*, 2 hours at 975° C, *B*, 2 hours at 1075° C, *C*, 2 hours at 1220° C

Shortly after the publication of my researches on manganese (*Jour. Iron and Steel Inst.*, **115**, 393; 1927) I carried out further experiments regarding the microstructure of the high temperature allotropes, and in view of Messrs. Persson and Öhman's results they may be of interest. Fig 1 A and B show the microstructures of a sample of manganese which has been heat-treated in hydrogen for 2 hours at 975° C. and 1075° C. respectively and then quenched in water. It is evident on comparing these structures that no change in crystal structure has occurred on passing through the 1024° C. transformation point—which supports the view held by the above authors. Fig. 1 C shows the structure of the same sample of manganese which has been heat-treated in hydrogen for two hours at 1220° C. and then quenched in water; a change in structure has obviously occurred.

Messrs. Persson and Öhman suggest that, since γ-manganese, *i.e.* electrolytic manganese, is in reality a high temperature modification, that is sufficient to account for its rapid transformation into α-manganese by heating to 150° C. This also accounts for the fact that no thermal change was observed by me in pure manganese, prepared by distillation *in vacuo*, over ranges of temperature from 30° to 300° C. MARIE L. V GAYLER.

National Physical Laboratory,
Teddington, Middlesex, Nov. 8.

### The Charge of an Electron.

LAST January I proposed a theory of electric charge which led to a definite prediction of the numerical value of the constant $hc/2\pi e^2$ Since then I have been trying to obtain fuller insight into the more obscure parts of the theory—places where it was necessary to trust to a sense of analytical form rather than to any definite conception of the physical or geometrical meaning of the formulæ I think that I have now been able to bring the theory into an improved form.

I hope to publish the full investigation soon; meanwhile I may state a result of general interest. According to the new calculation the value of $hc/2\pi e^2$ is 137. It is difficult to explain briefly the change from the former result (136); but, broadly speaking, it is due to the recognition that the 'rotation', which I introduced to represent interchange of the two electrons, is not one of the 136 symmetrical rotations of a pair of electrons, but is an antisymmetrical rotation which must be counted in addition. This was not very apparent so long as the rotation term was introduced solely as a consequence of the Fermi-Dirac principle; but the present theory goes more deeply into the origin of the term and makes clear its relation to the symmetrical rotations A. S. EDDINGTON.

Observatory, Cambridge, Nov. 20.

### Forestry Research in India.

IN connexion with the article on the above subject which appeared in NATURE of Nov 16, I should like to explain that the words "Towards the end of 1900 the first research work by the Forest Department was commenced, when a member of the forest staff was appointed", referred to the fact that this was the first whole-time appointment made with the object of undertaking a definite line of research. Executive officers of the Department had been engaged upon research work before (and after) 1900 in addition to their own duties, as exemplified by the valuable work done by the late Sir D Brandis, J. S. Gamble, and many others. When the Research Institute was incorporated in 1906, all the research officers were drawn from the gazetted ranks of the Department.

In view of the lamented death of Sir Sainthill Eardley-Wilmot, only a few days after the opening of the new research buildings at Dehra Dun, it may be added that, next to Lord Curzon, the officer most responsible for the new scheme was Eardley-Wilmot, at the time Inspector-General of Forests to the Government of India; for it was due to his vision and enthusiasm that the Research Institute came into being. THE WRITER OF THE ARTICLE.

## Quantitative Chemical Analysis by X-rays and its Application.[1]

By Prof G. Hevesy, Freiburg im Breisgau.

THE late H J G. Moseley was convinced that his discovery of X-ray spectroscopy would prove to be of value to analytical chemistry. He had chiefly the analysis of alloys in mind, and his well-known photograph of the brass spectrum, showing the stronger copper and weaker zinc lines, can be considered as the first application of X-ray spectroscopy in the field of analytical chemistry His untimely death prevented him from attacking any other problem than the connexion between atomic number and X-ray spectra. The result of his endeavour is well known, it led him to discover the fundamental law governing X-ray spectra

The first application of X-ray spectroscopy to the analysis of minerals was made in 1922 by Hadding in Siegbahn's laboratory. Shortly afterwards, Goldschmidt and Thomassen made a very exhaustive examination of the relative abundance of rare earth elements in a great number of different minerals By comparing the intensity of the X-ray lines, they concluded that very marked differences exist in the relative abundance of neighbouring even and odd elements, and confirmed the generalisation put forward by Harkins and Oddo

The important problem studied by Goldschmidt and Thomassen could be most satisfactorily solved without a strictly quantitative analysis, the differences between the abundance of neighbouring elements being very marked. The necessity for a strictly quantitative application of X-ray spectroscopy was, however, apparent when in the same year Coster and myself had to face the problem of the separation of hafnium from zirconium The two elements being so similar, it was necessary when testing the efficiency of a separation method to determine small differences in the hafnium-zirconium ratio. We added to the sample to be investigated just sufficient tantalum oxide to make the hafnium $L\alpha_1$ and tantalum $L\alpha_1$ lines appear in equal intensity on the photographic plate, and concluded that in this case the unknown number of hafnium atoms present equalled the known number of tantalum atoms Later, tantalum oxide was replaced by lutecium oxide and the intensity of the hafnium-$L\beta_1$ and lutecium-$\beta_2$ lines compared The wave-length difference of two lines amounts in the latter case to four X-units only, corresponding to $\frac{1}{5}$ mm. on the photographic plate. Closeness of the wave-length of the lines to be compared is of great advantage. The intensity ratio of these lines was determined experimentally and was found to be 2·55. Similar considerations to those which led to the choice of lutecium as the reference substance for the determination of hafnium induced us to take erbium as a reference substance when estimating tantalum, the lines to be compared being in this case tantalum-$L\alpha_1$ (1518·3 X units) and erbium-$L\beta_2$ (1510·6 X units), to use niobium or thorium when estimating zirconium, and so on.

[1] Paper read at a joint discussion between Sections A and B of the British Association at Johannesburg on Aug. 1.

The investigation of cases like those above mentioned, where a mixture of a few refractory oxides is to be analysed, can easily be carried out. In other cases, however, we encounter appreciable difficulties

### Sources of Error and their Elimination.

(*a*) Error is due to the fact that the initial ratio of the unknown element to the reference element in the surface layer of the sample, which alone is accessible to the exciting action of the cathode rays, changes during the experiment. (The half-value depth for $\beta$-particles, for example, accelerated by 20,000 volts is, in zirconium oxide, only $2 \times 10^{-5}$ cm ) This change, chiefly investigated by Coster and Nishina, is due to the effect of cathode rays on the sample; under the action of the latter, chemical reaction or melting of the sample can occur, which may lead to a partial separation or shift of one of the two elements to a deeper part of the sample which is inaccessible to the cathode rays Their action may in the same way lead to evaporation or electrostatic repulsion of one or both components

(*b*) The presence in the sample of other substances than the element to be estimated and the reference substance, which we shall for the sake of brevity call 'impurities', though they may constitute the larger part of the mixture, may influence the intensity ratio of the two lines. First, one of the two lines may be absorbed more strongly by the impurity than the other; and secondly, the X-rays emitted by the impurity may excite the two lines to be compared by secondary action and increase their intensity. This excitation can be a selective one, and can lead to a false intensity ratio due to the presence of the impurity.

The errors due to causes discussed under (*a*) can be eliminated by avoiding the use of cathode rays for the excitation of the X-ray spectrum of the sample to be investigated. Not the sample itself, but a target of tungsten is bombarded by cathode rays, and the X-rays thus produced are used to excite the spectrum of the sample to be investigated This method of X-ray analysis, where the secondary radiation is analysed, will be denoted as the secondary method, and the usual method, where the spectrum is excited by cathode rays, as the primary method. The secondary method has been used in several cases in recent years both by Glocker in Stuttgart and in my laboratory, and has been found to work very satisfactorily In my laboratory an electronic tube constructed by Coster, and admirably suited for this purpose, is used. By using 40 k w. and 10 milliamp., a fairly strong copper-$K\alpha$ line can be obtained in the course of three minutes. The energy necessary to produce a secondary line is very appreciably greater than that for a primary line of equal intensity, but in the case of the secondary method a much larger current can be used—up to 100 milliamp. and still higher.

This is due to the fact that in the latter case the energy is distributed over the large surface, whereas in the former case it has to be focused on a comparatively small surface of the sample

Besides the above-mentioned advantages, a further advantage should be emphasised When determining elements present only in minute amounts in the sample, it is often necessary to expose the plate for a long time to the action of the X-rays: in the case of the primary method, the time of exposure is limited by the fact that the continuous radiation emitted by the anticathode darkens the plate and covers the weak lines In the case of the secondary method, the continuous radiation reaching the plate being negligible, the exposure can be continued for a very long time.

The curve on the left of Fig. 1 shows the analysis of cyrtolithe obtained by the secondary method; while that on the right shows the analysis obtained by the primary method. From the former the hafnium oxide content works out to be 11·1 per cent, in good agreement with the value obtained by analysing the zirconium oxide plus hafnium oxide extracted from the mineral (11·3 per cent), while the primary method gives an entirely false result

While the errors due to the effect of cathode rays can be successfully eliminated by using the secondary X-ray method, as mentioned above, we may still encounter those discussed under (*b*). Selective absorption will occur when the absorption edge of an impurity, present in large quantities, is situated between the two lines to be compared. In this case a selective absorption of the line of the shorter wave-length can occur, for example, between nickel-$K\alpha_1$ (1655 X-units) and cobalt-$K\alpha_1$ (1785 X-units) the iron-$K$ edge (1740 X-units) is situated The presence of large amounts of iron

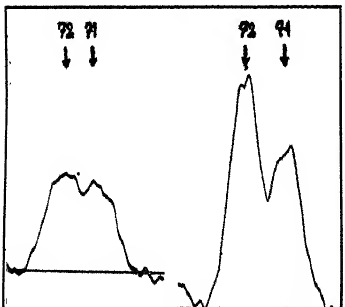


FIG. 1.—Photometer curves of cyrtolithe excited by X-rays (left) and by cathode rays (right)

in the sample can accordingly influence the intensity ratio. The most general remedy for such an error is to use very closely situated lines: when the wave-length difference is very small, the probability that an absorption edge will be situated between the two lines is only minute.

An example of the other case, in which strong lines of impurities are situated between the edges of the two elements to be compared, is the presence of large amounts of zinc in a mixture of tantalum and erbium The strongest lines of the $K$ spectrum of zinc ($\alpha_1$ $\alpha_2$, $\beta_1$) are situated between the edges of the latter elements The zinc lines can thus excite erbium but not tantalum, and are bound to shift the equal intensity ratio in favour of erbium

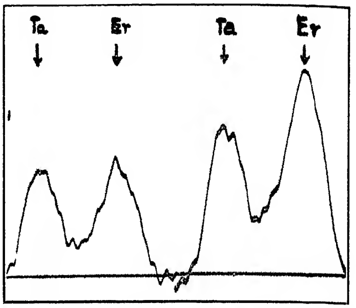


FIG 2.—Photometer curves of equal intensity mixture of tantalum and erbium alone (on left), and of the same mixture with the addition of five atoms of zinc for each atom of erbium (right).

On the left-hand side of Fig. 2 is seen the photometer curve of the equal intensity ratio of an erbium-tantalum mixture, and on the right-hand side the same with five atoms of zinc present for each atom of erbium. The equal intensity ratio is altered by 20 per cent owing to the presence of the large amounts of zinc In the not very probable case that tantalum should have to be determined in the presence of a large excess of zinc, a corrected equal intensity ratio would be necessary, or the erbium abandoned as reference substance and replaced by, for example, iridium

A third case of disturbance is encountered when the absorption edge of the impurity is situated between the absorption edges of the two lines to be compared This has, again, a weakening effect on the intensity of the line of the element with the absorption edge with the shorter wave-length.

The most general remedy for the disturbances we have just mentioned is the use of reference lines with closely situated edges. We mentioned previously as a remedy for other selective absorption errors the use of reference elements with closely situated lines; as both requirements—closely situated lines and edges—can only be found in a limited number of cases (about twenty), the X-ray analyst finds himself compelled to compromise between these two requirements. To be able to carry out accurate quantitative analysis of minerals or alloys with a great number of constituents, it is necessary to ascertain if large amounts of disturbing impurities are present and choose the reference lines suitable to the special case. If only an approximately quantitative method of determination is needed, these precautions are not necessary, nor are they necessary if an accurate analysis of a mixture of a few refractory oxides, for example $ZrO_2 + HfO_2$ or $TiO_2 + Ta_2O_5 + Nb_2O_5$ is to be carried out.

Full tables containing suitable reference lines for elements between sodium and uranium will be published shortly

### APPLICATIONS OF THE ANALYTICAL X-RAY METHOD

The chief field of application of the method of quantitative X-ray analysis is the determination of rare elements in minerals and alloys, but it can be applied to practically any element

*Minerals*—The determination of hafnium, which can only conveniently be done by the X-ray method, has already been mentioned A further example of X-ray spectroscopy as applied to minerals is the case of tantalum and niobium These can be separated by different chemical methods, but it is scarcely possible to effect a separation, or even to show the presence of the elements, when only traces are present in the mineral For example, the presence of tantalum or niobium in the most important titanium minerals, such as ilmenite, titanite, rutile (apart from ilmeno-rutile and struverite, which are rich in tantalum and niobium), was not known before the application of X-ray analysis, in spite of the fact that the largest amounts of tantalum or niobium in the earth's crust are actually to be found in titanium minerals This is due to the fact that niobium and tantalum generally accompany titanium in laboratory separations, and have likewise been deposited together by geochemical processes. They show conspicuously the phenomenon of a comparatively rare element being masked by a very similar abundant one, a phenomenon investigated by Goldschmidt and named by him ' camouflage '.

Tantalum and niobium being in many cases only present in a concentration of 1 in 1,000,000, it is necessary before applying the X-ray method to increase the concentration by a chemical one. Such a combination of chemical and X-ray methods proves in several cases to be very useful, especially in determining the abundance of the rarer elements in the lithosphere or in meteorites. While exhaustive data are available on the abundance of the more common elements, as shown by the well-known work of Clark and Washington, before X-ray methods were introduced, scarcely any data were available on the abundance of many of the rarer elements, though these constitute the majority. To determine the abundance of the latter in the lithosphere, the following method proved very useful. A large number of samples of igneous rocks were taken, in the same proportion as they occur in the earth's crust, and the mixture of the samples analysed by combined chemical and X-ray methods.

*Alloys.*—The method of quantitative X-ray analysis is very useful in investigating both common metals, such as commercial samples of iron, and also alloys of precious metals such as platinum. In the former case, minute amounts of vanadium, chromium, and so on, can also be determined by other than X-ray methods, for example, by the recently highly developed method of electro-analytical titration, but in this case it is necessary to dissolve the alloy, whereas in the X-ray investigation this is not necessary so long as the proportion of the metal present is not less than one in ten thousand. The X-ray method has greater advantages in the case of the platinum metals, where chemical analysis is very tedious.

*Soil Samples*—The analysis of soil samples should be quoted as a third case The phosphorus content, for example, can be determined conveniently and quickly by adding zirconium oxide to the sample and comparing the intensity of the phosphorus-$K\alpha_1$ and zirconium-$L\beta_1$ lines

We have discussed so far the use of X-ray emission spectra for analytical purposes An entirely different method of X-ray analysis makes use of the selective absorption by the sample containing the element to be determined This method, worked out by Glocker, can be used where one heavy element is present in large excess over several light ones, but in general it is preferable to use the emission method

We may refer in passing to the great progress made in quantitative optical spectroscopy. This progress is due to a great extent to the fact that the principle which was found very useful in the domain of X-ray spectroscopy, namely, the addition of a reference substance to the sample to be investigated, has also been introduced into optical spectroscopy. In the case of elements such as lead, zinc, cadmium, or the alkali metals, the optical method can be used with equal advantage, or in some special cases even more successfully than the X-ray method, but in the case of elements forming refractory compounds, such as the titanium group, the vanadium group, the rare earths, and so on, the optical method encounters serious difficulties which do not occur in the X-ray method.

### SUMMARY.

Quantitative analysis by X-rays is best carried out by first mixing the substance to be determined very thoroughly with a suitable reference substance. The intensity ratio of the reference line and the line to be determined is determined empirically beforehand. To avoid the disturbing effect of cathode rays, the sample is bombarded by X-rays, and the secondary spectrum investigated. As the presence of large amounts of certain impurities can influence the intensity ratio of the lines to be compared, it is necessary to know for each element under which conditions an exact determination is possible, and to choose the reference line accordingly. In the case of an approximate determination, and also in several cases of exact determination, this precaution is not necessary. The chief application of the method is the determination of rare elements present only in small amounts, where chemical methods more or less fail and the advantages of the X-ray method are most pronounced. Very promising also is the combination of the chemical and X-ray methods, as this allows, for example, a determination of all the rarer elements in the earth's crust and in meteorites. The analysis of soil samples (determination of the phosphorus content, etc.) and of alloys are further important applications.

## Cancer Research.

THE twenty-seventh annual report of the Imperial Cancer Research Fund contains, in addition to the usual survey of the work published from the laboratory during the year, an unusual feature in the form of a review by Dr W. Cramer of certain aspects of experimental carcinogenesis It is proposed to include such critical commentaries in future reports, and there can be no doubt that this policy will enhance the value of these publications, for in no branch of medical research is it more necessary to pause from time to time to order our conceptions of the central problems

The criticism is often made by those who are uninstructed in the facts that cancer research is sterile of results, and if by results is meant the complete explanation of malignant disease and the production of a perfect cure for it, the criticism is justified But those who are better informed realise that, apart from some stupendous fluke, the secrets of cancer will only be revealed by persistent and laborious work in as many directions as possible. Unemotional work of this nature has been carried on by the Imperial Cancer Research Fund for twenty-seven years, and though it has not resulted in the elucidation of the main questions, it has provided us with such a wealth of detailed knowledge that we may claim to know more about the malignant processes than we do about many other biological phenomena that are accepted as the commonplaces of existence

In this summary of the work of the current year, Dr. J. A. Murray, Director of the Fund, directs attention to certain observations which are of considerable interest Continuing his work on carcinogenesis, Dr. W. Cramer has come to the conclusion that the development of carcinoma is not entirely due to changes occurring in the epithelium, but depends to some extent upon the removal of local inhibitory factors present in the other tissue elements His observations suggest that the process of carcinogenesis consists of two phases—one a process of long duration which induces the condition of potential malignancy in the epithelial cells, and the other, a breaking down of the local resistance or inhibition which prevents the realisation of this potential malignancy Exactly which of the tissue elements are concerned in this inhibition is not known, but it is possible that the wandering cells which accumulate under the hyperplastic epithelial cells of skin which has been treated with tar may be responsible Certain observations by Dr. Ludford may have a bearing on this question. He has shown that in tumour-bearing animals vitally stained with trypan blue, the macrophages which take up the dye tend to accumulate around the tumours, though this distribution varies considerably in different types of growths. In view of the fact that the same type of macrophage is concerned with the taking up of metallic colloids from the blood-stream, it is possible that the action of metals on tumours may be an indirect one exercised through the macrophages.

Continuing his observations on the metabolism of the malignant cell, Mr Crabtree, applying the method developed by Prof. Warburg to the numerous strains of transplantable tumours available in the laboratories of the Fund, has confirmed Warburg's discovery that the cancer cell can split sugar into lactic acid in a far greater degree then normal cells Since this process is not confined to the cancer cell, it cannot be utilised as a test for malignancy, but it does indicate an important metabolic activity in which the tumour differs from the normal tissue, and since the metabolism of a cell is an expression of its vitality which can be measured, this technique offers a far better method for the study of the mode of action on the cell of therapeutic agents than we have hitherto possessed. Mr. Crabtree has started an investigation along these lines on the therapeutic action of radium which promises valuable results

Owing to the work of Gye and Barnard, much attention has been directed of recent years to the study of the filterable tumours of fowls Dr. A M. Begg has studied such a tumour which in the course of three years has altered in character from a slowly growing fibro-sarcoma of low malignancy to a more cellular, more malignant tumour transmissible by cell-free extracts It is highly probable, though not proved, that the tumour acquired the property of filterability with its assumption of a greater degree of malignancy

An exceedingly significant observation on the Rous tumour has been made by Dr Begg and Dr. Cramer It has been claimed that it is possible to transform normal cells of the fowl into malignant cells by the action of various substances such as arsenious acid, indol, and skatol. Further reports have been published of the isolated production of the Rous sarcoma by the inoculation of extracts of normal fowls' testis or pancreas These results have not been confirmed by other workers, but Drs. Begg and Cramer have brought forward evidence to show that such tumours may accidentally occur from the unsuspected contamination of laboratory apparatus with the virus of the Rous sarcoma. Such accidents are not unknown in the history of bacteriology, and the suggestion is made that these anomalous findings were due to experimental errors.

Dr. Cramer's review of experimental carcinogenesis is worthy of special study. The study of tar cancer in mice has thrown new light, for example, on such matters as the age incidence of malignant disease, and its occurrence in certain industrial occupations. It is responsible for the conception that different individuals of the same species vary in their susceptibility to the factors which are known to be associated with the development of malignant disease. If a certain proportion of human beings are susceptible to these factors, irrespective of dwelling-place, climatic or social conditions, the total incidence of cancer in all forms is likely to be the same in every nation; but local circumstances might lead to the relative prevalence of, say, intestinal or uterine cancer in any nation. This conception would offer a satisfactory explanation for the difference in the organ incidence of cancer which is such a striking feature in the statistics of different countries.

# Obituary.

## DR CHARLES HOSE

DR CHARLES HOSE, whose death on Nov 14 we much regret to record, was born on Oct 12, 1863 From his father he inherited that love of wild Nature which characterised him throughout his life As a boy, he was a keen naturalist and continued his habit of collecting and observing while at Felsted School. In 1882 he was admitted to Jesus College, Cambridge, but did not take a degree, as in his second year his uncle, the Bishop of Singapore, Labuan, and Sarawak, obtained for him a cadetship under Rajah Sir Charles Brooke, and on April 15, 1884, he landed at Kuching and was at once sent to the Baram district, where he remained for about eighteen years In 1904 he was appointed Resident of the Rejang district and retired on Aug. 20, 1907, when he returned to England In 1916, Dr Hose was appointed superintendent of the munitions factory at King's Lynn, and in 1918 was chairman of the Cotton-waste Mills Investigation Committee

Dr. Hose was given an honorary Sc D at Cambridge in 1900, and was elected an honorary fellow of Jesus College in 1926 He was a member of various scientific societies and the recipient of orders from several European countries A list of the publications by Charles Hose, compiled by Prof G H. F Nuttall, is given in "Fifty Years of Romance and Research of a Jungle-Wallah at Large" (1927), in which book will also be found an enumeration of the new genera and species of animals collected by him. A perusal of the titles of the papers written by Dr Hose or with his collaboration, and of those dealing with the specimens he collected, will give some idea of his remarkable energy and the width of his interests The result of his labours has been to add greatly to our knowledge of the zoology of Sarawak, and all anthropologists acknowledge the unrivalled extent and value of his contributions to the ethnography of that country

Mention should also be made of the prolonged investigations made by Hose into the cause of beriberi; he came to the conclusion that the principal cause of this disease in Borneo was the consumption of mouldy rice It is now admitted that the disease is frequently due to a preponderant consumption of white rice, that is, rice which has been polished by the removal of the husk and outer layers which alone contain the all-important vitamins. Dr. Hose's observations and experiments provided valuable data towards the elucidation of this problem. It was also due to his persistent efforts that the wealth of Sarawak has been enormously increased by the discovery and development of the greatest petroleum-producing area, except Burma, within the bounds of the British Empire. Hose was an insatiable collector, and a large number of museums throughout the world contain zoological and ethnographical specimens and collections given by him, but he did not neglect plants and geological specimens

When I was preparing for the Cambridge Expedition to Torres Straits, I received a most cordial invitation for my party to visit Dr. Hose in the Baram district His offer was so tempting in its promises that I could not refuse, and the results of that visit have been far-reaching. We had the opportunity of seeing the respect and affection in which the Resident was held by the varied tribes of the district, and how they came to him with their difficulties, which were often of a personal and intimate nature None of us will forget the wonderful gigantic peace celebration which cemented friendship between various estranged tribes and incidentally proved the power and beneficence of the Government

We found that Hose had a very extensive and detailed knowledge of the natives, which was stored in his remarkable memory and more or less recorded in notes He then began to collaborate with Dr W MacDougall, and the partnership finally resulted in the great and richly illustrated work, The Pagan Tribes of Borneo" (2 vols., 1912), which will be a lasting memorial to Charles Hose It was a happy combination, for though he was supreme as a collector and observer, Hose had never had a scientific training, and the method and restraint of MacDougall were of great service in bringing the great wealth of crude matter into due form.

To the last Dr Hose retained his youthful enthusiasms and outlook; he was always seeking to know about things, and when that knowledge was obtained he utilised it in various ways. He was essentially a field naturalist, and these qualities, combined with his genial character and his sympathetic appreciation of native thought and custom, enabled him to become a notable administrator who has left an indelible impression on his beloved Sarawak

A C HADDON.

## PROF. RICHARD ZSIGMONDY.

SCIENCE generally has suffered a very severe loss by the recent death of Prof Richard Zsigmondy, late Director of the Institute for Inorganic Chemistry at Gottingen. For years he has been one of the most prominent figures in the field of colloid chemistry

Richard Zsigmondy was born in Vienna on April 1, 1865. Even as a young boy he showed great aptitude for experimental science, and he pursued the study of chemistry at the Technical High School at Vienna and at the University of Munich After graduating for the degree of D Phil., he became private assistant to Prof. Kundt at Berlin, and in 1893 he obtained his "Privatdozent" at the Technical High School at Graz. Four years later he was employed as scientific worker by the well-known firm of glass manufacturers, Schott of Jena. The outcome of his investigations with this firm was the preparation of a specially uniform Jena opalescent glass. After leaving the firm, Zsigmondy became a private teacher in Jena, and it was during this period that

he carried out and completed some of his most well-known investigations

Zsigmondy's early work was concerned with glass and the colours produced by the presence of metals or metallic oxides This led him to take up the study of colloid chemistry, and in 1898 he published his well-known work on colloidal gold He successfully prepared gold sols of reproducible properties and showed that they owed their colour to minute particles of metallic gold, which were held in suspension by the electric charge they possessed. He further showed that removing this charge by the addition of electrolytes precipitated the gold and it was impossible to bring the precipitate back into suspension Zsigmondy very quickly realised that the colour of his gold sols closely resembled that of gold ruby glass, and he turned his attention to this material, with the result that he definitely proved that ruby glass also owed its colour to the presence of very minute crystals of metallic gold.

Another problem which was attracting a great deal of attention at this time was the constitution of Cassius purple. Very many chemists, including Berzelius, believed that this substance was a chemical compound, but the whole question was satisfactorily solved by Zsigmondy when he synthesised the purple from colloidal gold and colloidal stannic acid. Furthermore, his method of determining the relative protective power of hydrophyllic colloids by means of the gold number is familiar to all colloid chemists.

These investigations on colloids proved that for the successful observation of these small colloidal particles more refined apparatus was necessary Zsigmondy concentrated his energies on the solution of this problem and conceived the idea of the ultramicroscope, which, with the collaboration of Prof. Siedentopf, he brought out in 1904. This new apparatus enabled chemists to observe particles which hitherto had been invisible and it gave a new impetus to the direct study of the Brownian movement.

In 1907, Zsigmondy was called to Gottingen as Director of the Institute for Inorganic Chemistry, which he converted into a school of colloid chemistry where students from all over the world collected to study this branch of chemistry. During the early period of his stay at Göttingen, Zsigmondy turned his attention to the study of gels and gel structure, and he put forward the generally accepted capillary theory for the explanation of vapour pressure curves of silica gels as determined by van Bemmelen. His work during this period gave the study of gel structure a new interest and importance in the minds of chemists.

Later, Zsigmondy became interested in the preparation of collodion membrane filters. With characteristic thoroughness he explored the various ways and means of obtaining reproducible filters of definite and uniform pore size. This was essential if the filters were to be of any use in either colloid chemistry or bacteriology and biology. The final outcome of a period of intensive investigation and experiment was the preparation of the now widely used Zsigmondy membrane filters These investigations were carried still further with the production of very uniform ultrafilters of varying pore size down to a diameter of about 4 $\mu\mu$ With further work he succeeded in preparing 'cella' filters for use with organic solvents. Zsigmondy was awarded the much-coveted Nobel Prize for chemistry for 1925 in recognition of his important pioneer work in the comparatively new field of colloid chemistry.

Zsigmondy made some excellent contributions to the literature on colloids in general. In 1905 his "Erkenntniss der Kolloide", containing a full account of the development of the ultramicroscope and of his original work, was published The first edition of his general treatise on colloid chemistry appeared in 1912, and a completely rewritten edition in 1927 Another contribution, in which he collaborated with Dr Thiessen, is "Kolloides Gold", which is one of the few standard works on the subject.

In February 1929, Zsigmondy was forced by failing health to retire from his duties at the Institute, and in October last he died at his home at Gottingen. To those who had the privilege of working under him, it was felt as a personal loss of an inspiring teacher and a sincere friend, while the whole scientific world must feel that one of its great men has passed away.

## Dr. T. Wemyss Fulton.

More than fifty years ago Thomas Wemyss Fulton and I worked side by side in Turner's dissecting-room in Edinburgh, with David Bruce and Noel Paton among our comrades there. D. J. Cunningham, then senior demonstrator, was studying the anatomy of the *Challenger* marsupials; the junior demonstrator was designing the Cathcart microtome; and the laboratory attendant, 'old Stirling', the real first inventor of the microtome, was making his exquisite preparations, as Goodsir had taught him to do. A prize, of some value for those days, was given for the best dissections of the year; I have forgotten its name, but I remember that I won it one year and Fulton the next Scholarships were few and scanty. Many of us found some employment, to help pay our way—in part or whole; and Fulton, with indomitable strength, courage, and self-denial, was a telegraphist by night in the G.P.O. and a medical student by day. He graduated with first-class honours; and when he took his M.D., three years later, his thesis was a study of 'telegraphists' cramp', based both on observation and experience.

John Murray, a good judge of men, took Fulton as one of his assistants in the task of seeing the *Challenger* Reports through the press. After a couple of years of this useful experience, Prof. Cossar Ewart brought him into the Scottish Fishery Board's service; and there he remained, afterwards becoming the Board's scientific superintendent under the Act of 1895.

Dr. Fulton's own papers began to appear in

Board's report for 1888, and the output went on steadily for thirty-four years He made countless observations and not a few discoveries regarding fishes, their early development and subsequent rate of growth, their migrations and distribution, their habits and their food Some of his best papers were those in which he demonstrated (in 1895 and later) the cyclonic surface-currents of the North Sea, and the influence of this circulation on the distribution of fish-eggs and young fishes

Beam-trawling began in Scotland just a little while before Fulton came to the Fishery Board the otter trawl followed about 1895, and at once ousted the beam, and the fishermen complained bitterly of the new industry At first the Board was little in favour of restrictions, in 1884 it pronounced against a *mare clausum*, adding, however, that "the true principle is freedom, *qualified by such regulations* as in the common interest may be found just and necessary" Dr Fulton's sympathies were all with the line-fishermen, he wished to protect them, and his influence had a deal to do with shaping the policy which closed the Firths of Forth and Clyde and the great area called the Moray Firth He convinced himself, more than forty years ago, that there had "already been a gradual and considerable diminution of the average catch of Scotch beam-trawlers, per ton of the vessel's tonnage", and he said that "it would not be seriously contested that the supply of fish, relative to the machinery of capture, has diminished and is likely to continue to diminish".

Very difficult questions soon arose out of the closure of the Moray Firth, and helped to turn Fulton's attention to the thorny subject of maritime law. In 1911 he published his *magnum opus*, on the "Sovereignty of the Sea". The lawyers have not always, I believe, seen eye to eye with him on matters of opinion or interpretation: but the book, obviously and admittedly, is a mine of historical information and curious learning. The earlier chapters, especially those on our troubles with the Dutch in Charles II's time, are delightful reading D'Arcy W. Thompson.

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### Col. Sir Thomas Holdich, K.C.M.G., K.C.I.E.

Sir Thomas Hungerford Holdich, who died on Nov. 2 at the advanced age of nearly eighty-seven, spent most of his active life in the Survey of India, where he was largely engaged on Frontier and trans-Frontier work. His commission in the Royal Engineers dates so far back as 1862. His first war service was with the Bhutan Expedition in 1865, followed by the Abyssinian campaign in 1867 and the second Afghan War in 1878–80. But his survey career will chiefly be remembered by his work on successive boundary demarcation commissions, and probably he served on more of these than any other office. In 1884 he was with the Russo-Afghan Boundary Commission in connexion with which the once famous, though now almost forgotten, Panjdeh incident took place. As superintendent of frontier surveys he was concerned with the extension of maps on and beyond the Indian frontiers During this period he was engaged in 1894 on the demarcation of the eastern boundary of Afghanistan, between that country and the frontier tribes In the following year he was with the Pamir Boundary Commission. Finally, he was appointed chief commissioner for the demarcation of the frontier between Persia and Baluchistan In 1898 he retired after thirty-six years' service in India

With such a record it is not surprising that Holdich was appointed, shortly after his retirement, to be a member of the tribunal dealing with the disputed boundary between Argentine and Chile, which had been referred to King Edward as arbitrator This tribunal, presided over by the late Lord Macnaughton, heard evidence from both sides in London A stage in the proceedings was reached, however, when it became necessary, through lack of geographical information, that the country in dispute should be inspected For this purpose Holdich and a party of survey officers visited Chile and the Argentine during the winter of 1901–2 After the additional evidence thus collected had been placed before the tribunal, King Edward gave his award in the autumn of 1902

In the meantime, the two countries decided that the actual boundary, as awarded, should be marked out on the ground in the presence of a commission appointed by the British Government. Holdich became chief commissioner for this purpose and again visited South America in the winter of 1902–3 The final settlement of this important boundary, which had been the cause of continuous and dangerous friction between Argentine and Chile, was at last completed. This was one of Holdich's most successful achievements He possessed in an eminent degree the art of conciliating divergent elements, which gave him a great advantage in dealing with questions of this kind He had the pen of a ready writer and was also a fluent and pleasant speaker. The excursions which he made into the historical and picturesque aspects of trans-frontier exploration were much appreciated He was also an admirable artist, and brought back many pictures of the various places he visited.

Holdich's inclinations always seemed to tend towards the political, artistic, and literary, rather than to the scientific side of life, which did not really interest him. For his various services he was made at different times K.C.M.G., K.C.I.E., C.B., and C.I.E. He served as president of the Royal Geographical Society from 1916 to 1918, and he was the oldest holder of the Society's gold medal. He was the author of several works, notably "The Indian Borderland", "The Countries of the King's Award", and "The Gates of India".

H. L. C.

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### Rev. Camillo Melzi d' Eril.

Father Camillo Melzi d' Eril, who died on Mar. 10 last, was born on Jan. 6, 1851, and thus at the time of his death was one of our oldest seismologists He was educated at the Carlo Alberto College, Moncalieri, and later was admitted to the Barnabite Order. In 1873 he joined the teaching

staff of the Collegio alla Quercé at Florence Here he was a colleague of Father T Bertelli, the founder of microseismology For many years he was director of the geodynamic observatory belonging to the college Following in Bertelli's footsteps, Melzi made a special study of microseismic motions, concluding that their frequency increased with a low barometric pressure, but that it was independent of the velocity of the wind On the death of Bertelli, he contributed a valuable account of his life and work to the *Bollettino* of the Italian Seismological Society (vol 10, pp 179-196, 1904)

C D.

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WE regret to announce the following deaths.

Sir Sainthill Eardley Wilmot, K C I E, from 1903 until 1906 Inspector-General of Forests in India, on Nov. 13, aged seventy seven years

Dr Ninian McIntire Falkiner, for about twenty years Medical Superintendent of Statistics for Ireland, on Oct. 30, aged seventy-four years.

Mr G B Francis, formerly a director of British Drug Houses, Ltd, who was an original member of the Society of Chemical Industry and for many years an honorary auditor of the Pharmaceutical Society, on Nov 6, aged seventy nine years

Prof. G. A Goodenough, since 1910 professor of thermodynamics at the University of Illinois, known for work on the properties of saturated and superheated vapours, on Sept 30, aged sixty-one years.

Dr. James Cosmo Melvill, who was elected a fellow of the Linnean Society so long ago as 1870 and was also a past president of the Conchological Society, on Nov. 4, aged eighty four years

Sir Archdall Reid, K B E, author of works on heredity in man and allied subjects, on Nov 18, aged sixty-nine years.

Dr. Samuel Rideal, president in 1918 of the Society of Public Analysts, who was well known for his work on sewage purification, on Nov 13, aged sixty six years.

Dr Harold W. T Wager, F.R S., formerly H.M. Staff Inspector of Schools, Secondary Branch, Board of Education, who was president of Section K (Botany) of the British Association at the South Africa meeting in 1905, on Nov. 17, aged sixty seven years

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## News and Views.

THE debate in the House of Commons on Nov. 20 on Empire timber resources was largely confined to a reiteration of the view that the world will be faced with a famine in softwood coniferous supplies in some thirty years' time. The debate originated from a resolution moved by Sir George Courthope to the effect "that the threatened shortage of commercial softwood timber demands the serious attention of His Majesty's Government". Sir George said that foresters regard the position with grave alarm. This, however, is stating but half the case, for many timber merchants agree with the foresters On the other hand, there is a body of opinion comprising both foresters and timber merchants who do not acquiesce in this alarmist view. They hold that as the supplies of the commodity in question become less abundant prices will rise, other materials will replace, to some extent, the softwood timbers; and that, with the ingenuity and adaptive faculty of the various trades, matters will readjust themselves The arguments concerning the exhaustion of Canadian supplies in thirty years, the competition of the United States with the British Empire, and the scanty supplies which would by then be left in Northern Europe, have all been alluded to in our columns on previous occasions. It is not, however, apparent upon what source of information Sir George Courthope bases his statement that "in Russia, certainly within twenty-five or thirty years, production will be forced down to a limit which does not exceed their own requirements, and the capacity to export timber will have ceased". This is very far from being in agreement with opinions held by some continental experts, who are probably in a far better position to know the true position than most in Great Britain.

AFTER an appreciative allusion to the ten years' work of the Forestry Commission, which has planted 140,000 acres of softwoods and 6000 acres of hardwoods, and has rendered assistance to local authorities and private enterprise to deal with some 50,000 acres more, Sir George Courthope said that the Commission would shortly be planting 40,000 acres a year. He suggested that a good deal could be done in encouraging the replanting and conservation of existing woods, that there is very definite scope for research, and that the laboratory at Princes Risborough will be so extended as to enable it to deal with forest products from all parts of the Empire In the debate which followed, in which the replanting of areas felled during the War and since, was strongly stressed, Mr. Buxton stated that the late Government announced last spring a programme of £5,500,000 for the next decade's work with a planting programme of 237,000 acres and 1500 small holdings attached The plan adopted by the present Government involves a sum of £9,000,000, an area of 350,000 acres, and the provision of 3000 small holdings, and it is hoped that this big programme will have a really useful effect on the rural economy in many districts and help to retain the rural population

THE cause of the preservation of the wild fauna of the British Empire cannot but benefit from the publicity given to it in the debate in the House of Lords on Nov. 21. No political partisanship is shown in this matter, for every speaker spoke with abhorrence of the slaughter which has been carried out under the name of 'sport'. Two widely different aspects of the question of killing wild animals cropped up in the course of the discussion. There is the new development of the running down and shooting of antelopes and the like by means of motor-cars, an inexcusable travesty of the sporting idea, which is not only condemned on all hands, but, as Lord Passfield pointed out, is also definitely illegal. The difficulty in Tanganyika is just that which confronts the animal protectionist, whether he is dealing with legal shooting grounds or great animal reserves, namely, that the law is bound to be ineffective in

face of the criminally disposed hunter, it the area is not under thorough surveillance by a large staff of wardens. This is an expensive business unless, as some of the colonies have contrived, the cost of supervision is borne by the profits made from the necessary reduction of surplus wild stock. The Legislative Council and the Governor of Tanganyika are doing their best to prevent illegal and excessive shooting, and the debate should encourage them in their efforts.

THE second aspect is the slaughter of wild animals by natives in their own territory. This question cannot reasonably be confined, as the Earl of Onslow suggested, to the protection of crops against depredations or of human beings against dangerous foes. From time immemorial the natives have depended on their own wild animals for food, and to deprive them of this right would seem to be a hardship. The difficulty is that in recent years there has been a tendency in some parts to slaughter for the sake of killing, irrespective of actual food requirements. We have been assured by African travellers that this development is directly due to the inordinate killing caused by sporting expeditions, the native, less passive than he would seem, saying to himself that since the whites are killing out the animals, he may as well kill them also. Here the cure would seem to be the setting of a good example rather than penalties which must give the impression of unjust differentiation. But where a real danger of extermination looms on the horizon, every effort must be made to protect the threatened creatures from anyone whomsoever. It strikes us as curious and inconsistent that while all this strong and unanimous discussion concerns itself with the wild creatures in wild country, where the danger of extermination is on the whole far off, men may still kill the last remnants of some of the interesting relics of the British fauna, to their own considerable profit, and without running the risk of the slightest penalty, for except in the case of the grey seal there has been no attempt on the part of the British legislature to protect British mammals.

SUBJECT to the approval of the Charity Commissioners, an agreement has been reached between the Radcliffe Trustees and Sir William Morris, Bart., president of the Radcliffe Infirmary, by which the Trustees will sell to Sir William (on behalf of the Infirmary and the University Medical School) the whole of the Observatory grounds, which extend to more than nine acres, and the Trustees will take a lease of the Observatory buildings and part of the grounds for a period of five years, to enable the completion of the observational programme on which the Observatory has for some years been engaged, the determination of the proper motions of some 30,000 stars in the Kapteyn Areas. The Radcliffe Observatory will then be moved to South Africa. Its new site has not yet been finally selected, but it will be somewhere on the high central plateau, where the atmospheric conditions for astronomical work are second to none in the world.

LIKE the Radcliffe Library and the Radcliffe Infirmary, the Observatory was formed by the trustees of the estate of the famous physician, John Radcliffe (1650–1714), the first Radcliffe Observer being Thomas Hornsby (1733–1810), who was appointed in 1772 and under whose direction the observatory was erected and equipped at a cost of £28,000. The original instruments included two quadrants and a transit instrument, a zenith sector, an equatorial and a Dollond achromatic refractor, to which later on a Newtonian reflector by Herschel was added. Hornsby had succeeded Bradley as Savilian professor in 1763, and on the erection of the Observatory commenced a regular series of transit observations. At present the Observatory is the second oldest in the British Isles, and it has been the scene of the labours of many notable astronomers. Radcliffe was a fellow of Lincoln College, Oxford, and graduated as a bachelor of medicine in 1675. After practising for some years in the University, he removed to London and soon rose to the head of his profession, occupying much the same position that Sydenham did before him. Of strong common sense and independent views, he was very outspoken and sometimes rough, but of great liberality. He died at Carshalton, Surrey—according to his earliest biographer " a victim to the ingratitude of a thankless world and the fury of the gout "—but he was buried on Nov. 27, 1714, with much ceremony at St. Mary's, Oxford.

HEARTY congratulations were due this week to the veteran Sir James Crichton Browne, who, on Thursday last, celebrated his eighty-ninth birthday, and also to Prof. Horace Lamb, who, on Wednesday last, attained his eightieth birthday. Sir James Crichton Browne was educated at Dumfries Academy, graduating thence, in the medical faculty, at the University of Edinburgh. For forty-seven years he was Lord Chancellor's Visitor in Lunacy. For many years he was treasurer of the Royal Institution. Despite his great age, his interest in the Royal Institution is maintained; at the ensuing general meeting of members on Dec. 2, he will attend and make a presentation to a retiring officer of the staff whose services have covered half a century. Sir James Crichton Browne was elected into the Royal Society in 1883.

FOR upwards of forty-five years, Prof. Lamb has been recognised as the most prominent and successful worker in applied mathematics in Great Britain. In hydrodynamics he is a world-known authority. In the mathematical questions involved in the discussion of forces in aircraft, the action of screw-propellers, and stresses in aeroplane structure generally, his assistance has proved of high value. Awarded the Royal Society's Royal medal in 1902 for mathematical investigations, this was confirmed in ampler measure in 1923 by the allotment of the Copley medal. President of the British Association at the Southampton meeting of 1925, Prof. Lamb gave an address dealing in the main with geophysics. But some remarks of his on that occasion may be recalled as bearing on certain recent aspects of officialism in the State. "The habit", he said, " of sober and accurate analysis which scientific pursuits tend to promote is not always favourable to social and economic theories, which rest mainly on an emotional, if very national basis. There is, I think,

a certain dumb hostility, which, without venturing on open attack, looks coldly on scientific work except so far as it is directed to purposes of obvious and immediate practical utility.' Prof. Lamb was elected into the Royal Society in 1884.

IT is satisfactory to learn that the structural alterations lately decided upon at the Royal Institution are going forward with a minimum of delay, so that the amenities enjoyed in normal times by the general body of members are within reasonable distance of renewal. Further, that these alterations are so designed that the aspects and qualities of the historic rooms and of the theatre are being carefully preserved. We trust, as do many who hold the Royal Institution in deep regard, that in the end that old-time atmosphere, that flavour of great personal traditions which here appeals so strongly, will be found not entirely disconnected with the efforts of rehabilitation. If any doubt existed as to the advisability of reconstructing the theatre, it has been removed during the dismantling of the structure by the disclosure of the dangerous condition of the woodwork. In the course of a century, dry-rot had obtained a hold in many parts.

THE financial problems arising from the various alterations to the Royal Institution are, of course, extremely onerous. Although those whom we may perhaps call the friends of the Royal Institution have generously responded to a first financial call entailed by the scheme, a balance of about £17,000 is still required. The Royal Institution with its laboratory, fine library, and rota of experimental and philosophical lectures, is something beyond a mere London society of persons interested in the movements and progress of science. In effect it is a bequeathment to posterity by Rumford, Davy, Faraday, Dewar, the repercussions of which are international. Accordingly strong hopes are entertained that the necessary sum will be forthcoming. Apart from physical science it is worth recalling that the Royal Institution in early days took a hand in the promotion of geology and mineralogy. By the year 1804 a museum of more than 3000 mineral specimens and fossils had been brought together, including a special collection of minerals formed by Davy. During the years 1805–7 Davy lectured occasionally on geology as well as chemistry, and he was one of those present at the meeting in Freemason's Tavern, Great Queen Street, on Nov. 13, 1807, when it was resolved to institute a Geological Society. Faraday became a member of the Geological Society in 1824.

IN his Croonian Lecture on "The Developmental History of the Primates", delivered to the Royal Society on Nov. 21, Prof. J. P. Hill gave an illuminating summary of his investigations, extending over many years, on the evolution of the placenta and the early phases of the embryo in the Primates. The results of this difficult and exacting work emerge from the complexities, which are so bewildering to all except a few specialists, as a lucid statement defining a series of facts of observation easily susceptible of confirmation. Hence the evidence provided by Prof. Hill's laborious researches should establish once for all the true relationships of the four groups into which he subdivides the Primates. Man and the anthropoid apes are included in the same group, which was derived from the stage revealed in monkeys, both of the Old and the New World. This Pithecoid stage is clearly an advance on the Tarsioid type of placentation, which is displayed in the solitary survivor of the group, the spectral tarsier. It is equally certain that the Tarsioid placentation was derived from a primitive Lemuroid type, which can be inferred from the common denominator of the diversely specialised forms found in the living lemurs, galagos, lorises, and indrisines Prof. Hill has demonstrated that the Lemuroidea certainly belong to the order Primates, and that man is nearly related to the anthropoid apes, the common ancestors of which must have passed successively through both Tarsioid and Pithecoid stages in their descent from some pre-Tertiary Lemuroid. The evolutionary process of adaptive specialisation involves a speeding-up and an abbreviation of the developmental processes.

THE Huxley Memorial Lecture of the Royal Anthropological Institute was delivered by Baron Erland Nordenskiold in the lecture theatre of the Royal Society, Burlington House, on Nov 26. Baron Nordenskiold chose as the subject of the address "The American Indian as Inventor", a subject on which his prolonged study of American technology and his journeys of anthropological exploration in Central and South America have made him peculiarly competent to speak In his lecture he dealt with the question as to the extent to which we may suppose that the American Indians have independently invented many things entirely uninfluenced by the Old World. He gave numerous examples of inventions and discoveries that must necessarily be of original Indian conception, seeing that they were unknown in the Old World prior to the discovery of America. Among such he mentioned the use of poisonous manioc for food, tobacco and tobacco pipes, the rubber ball, rubber syringe, and the hammock; quinine, curare, and other poisons; the use of cayenne pepper in the preparation of a poison gas employed in siege warfare; the welding of copper; various kinds of musical instruments; calculating by means of knotted strings by the decimal system, and so forth. He asked whether it may not reasonably be supposed, seeing that the Indians discovered so much that was unknown in the Old World, with its variegated culture, that they may also have discovered various things that were known there. In the course of the lecture it was repeatedly emphasised that what was said did not constitute any conclusive evidence that there might not have been some pre-Columbian intercourse between the cultures of the Old and the New World. Even if there had been intercourse, it does not constitute proof that everything of common possession must necessarily derive from a common origin. At the close of the lecture the Huxley Memorial Medal of the Royal Anthropological Institute was presented to Baron Nordenskiold by Prof. J. L. Myres, president of the Institute.

THE November issue of the *Realist* contains stimulating article by Mr. J. B. S. Haldane upon a

place of science in western civilisation. Mr Haldane's forceful style is always attractive, but when it is exercised upon so fruitful a topic as the present it shows to particular advantage The main thesis of the article is that western civilisation has completely failed to integrate into its intellectual structure the scientific ideas that furnished its material structure There are thus two alternatives before it In the first place, scientific ideas may not be accepted by the ruling class, in which event Mr Haldane foresees further wars, spiritual decay, and a drying-up of the flow of real invention The second alternative is that a serious attempt will be made to incorporate scientific ideas, as well as scientific inventions, in our national and international life If this attempt were made, and succeeded, it would do much to fill the emotional gap which is left "by the collapse of the religious picture of the universe", for the scientific point of view is lofty enough to satisfy any of the aspirations of the human spirit According to Mr. Haldane, Soviet Russia has chosen the second alternative. He says that there is "any amount" of research being done in Russia, and that there is an intense general interest in science The children in the towns of Russia, he avers, learn a great deal more science than the corresponding children in England, and the scientific workers are relatively, though not absolutely, much better off than they are in Great Britain While we agree with Mr. Haldane that western civilisation has far to go before it properly appreciates the true value of science, we cannot help contrasting his roseate account of Soviet Russia with the diametrically opposite estimate given by Mr. Lancelot Lawton a few pages further on in the same issue of the *Realist.*

DR. CHARLES SINGER also has an article in the November *Realist*, on the "Dark Age of Science". After observing that science is a process and, like most processes, can be reversed, he states that, so far as science is concerned, the whole course of history presents no clearer division than that between the earlier Middle Ages or 'Dark Age' and the later Middle Ages or 'Scholastic Age'. The critical event is the arrival of Arabian influence in the twelfth and thirteenth centuries When in contact with a new medieval document, the first question that the historian of science asks himself is whether he can discern Arabian influence in it. If he can, the document is placed in the scholastic category; if he cannot, in the Dark Age category. Dr. Singer exemplifies the characteristics of Dark Age 'science' by reference to the "Handboc" of the monk Byrhtferth of the monastery at Ramsey. This was written half a century before the Norman conquest of England, and has recently been edited, with a translation, by Mr. S. J. Crawford. Byrhtferth was a good average Dark Age writer, and Dr. Singer condemns him and his contemporaries, referring to "the sophisticated childishness, the inane learning, and the humourless edificatory imbecility of the men of those times". His book is worth perusal by those who dwell in the light that science has since shed. The charge against the Church of having destroyed ancient science is, in Dr. Singer's opinion, unfounded, for there was practically nothing to destroy. When, in the sixteenth and seventeenth centuries, she did oppose independent thought, it was because the discoveries and theories of Copernicus, Giordano Bruno, and Galileo threatened to overthrow the doctrine—fundamental from the Church's point of view—of a finite universe.

THE relationship between biological phenomena and weather is of profound interest to the naturalist, and the "Report of the Phenological Observations in the British Isles from December 1927 to November 1928", published by the Royal Meteorological Society, supplies a wonderful assortment of data for consideration and speculation The labour of collecting and tabulating the notes from the 467 stations now in being must be enormous, and were it not that generalised results are shown, the tables and individual records are not such as the general reader can peruse with any satisfaction to himself A comparison of the excellent charts brings out some interesting results. The lines throughout the British Isles (migrant isophenes) interpreting the equal arrival dates of twenty selected migrant birds, show that the earliest arrivals occur on the south-east coast of England, that coastal arrivals precede inland arrivals, the coastal dates up to the Wash-Mersey line being some three days later than the south coast dates, to the Tyne-Solway line six days later, and to the north of Aberdeenshire nine to twelve days later. It is a striking fact that there appears to be some correlation between the floral isophenes and the migrant isophenes, and this, since it connects local conditions of flowering and the appearance of birds which have set out from distant places, seems to indicate the influence of very far-reaching weather conditions.

DURING the four weeks ending Oct. 17 there has been a remarkable increase of seismic activity in the island of Hawaii The numbers of earthquakes registered at the Kilauea Observatory suddenly rose from 9 during the week ending Sept 18 to 221, 244, 129, and 97 during the succeeding weeks, the origins of the shocks being concentrated below the Hualalai Volcano, a mountain 8269 feet high on the west side of Hawaii. Two strong earthquakes of intensity 9 (Rossi-Forel scale) occurred on Sept. 25 and Oct. 5. Though, after the latter date, there was a marked decrease in strength and frequency, the occurrence of this tremor-storm suggests that the Mauna Loa lava column, which has sent out its flows from the south-west rift of the mountain during the last twenty-five years, is now moving underground towards Hualalai. The decline in activity may imply that the mountain fissures are more open and the lava outburst near at hand.

IN telephony many attempts have been made to increase the speed of communication between automatic exchanges and manual exchanges, and specially between subscribers having automatic telephones and those connected with rural exchanges. It is stated in a recent issue of the *Times* (Nov. 9), that the Bell Telephone Laboratories have made a considerable step in this direction and have given a public demonstration of their new method. They use talking films to

assist in the operation of automatic telephones The device consists of ten films, one for each number from zero to nine. These are recorded by an operator specially selected for her telephone voice The films are wound on drums installed in the exchange. The dialling by the subscriber of the number required automatically releases the films, which revolve and call out the number required to the exchange operator. It is expected that many of these film-calling devices will be in practical use in a few weeks' time. A demonstration was also given by the Bell Laboratories of an improved means for ensuring the secrecy of radio-telephonic conversations. The method adopted is to 'scramble' the words of the message In the course of the transmission the high frequencies are changed to low frequencies and vice versa. The frequencies are then inverted and the conversation becomes intelligible. Before the retranslation, the sounds are completely unintelligible.

AT the Institution of Electrical Engineers, on Nov. 21, three papers were read dealing with the low temperature carbonisation of coal with special reference to its combination with the production of electricity. One of the papers described English practice, another American practice, and the third German practice. Whilst most other countries have hydro-electric power to fall back upon, the amount of power available from this source in Britain is never likely to provide more than about one-twentieth of our total power requirements. It is suggested that the power plant of the future will take in coal as its raw material, but will deliver, in addition to electricity, motor spirit, fuel oil, creosote, pitch, and other derivatives of coal tar. The present coal distillation plant at Dunston-on-Tyne produces from one ton of Northumberland small coal, 16 gallons of tar oils, and ¾ ton of semi-coke. It is stated that a wide and promising field of research in this direction has not yet been explored, although the first step has been taken. It is most important that coal, the valuable national asset of Britain, should be fully utilised.

IN America great interest is taken in the carbonisation of fuel, and the trend of progress is towards the co-operation of the electric companies with public service companies supplying gas for domestic and industrial purposes. Germany's coal industry is characterised by the competition between pit coal and brown coal. The pit coal is similar to that used in England, whilst the brown coal is of very inferior value until it has undergone suitable treatment. The production of brown coal, of which there is an almost unlimited supply, already amounts to 170 million tons a year. The cost of pit coal, however, will probably increase owing to the increasing depths of the pits. A large combination steam and brown coal carbonisation plant is now in operation. Germany is looking forward to the combining of carbonisation plants, power stations, and gas works.

A NUMBER of spectacular experiments involving the use of sound-films, photoelectric cells, and reproducing apparatus were demonstrated by Mr. J. B. Taylor, of the General Electric Co., Schenectady, in a lecture given on Nov 6 to the New York Electrical Society. An image of the sound track of the film after projection on to the screen was used to actuate a loud speaker through the medium of a photoelectric cell Various distortions of reproduced speech were then demonstrated by running the film at speeds up to three times the normal, by running the film in the reverse direction, and by increasing or decreasing the width and position of the slit, thus allowing selected and restricted portions of the sound track to act on the cell The rapid fluctuations in intensity of apparently constant sources of light were also demonstrated as sounds by allowing them to illuminate the photoelectric cell of the sound reproducing apparatus.

IT is well known that the principles governing successful communication over long distances on land and sea have their origin in optical, acoustic, and mechanical methods which were used in primitive times. Through revolutions, wars, and reformations the art of signalling by these means can be traced to the beginning of the nineteenth century, when it attained its highest perfection under Claude Chappe, the first administrative telegraph engineer in France. Mr Rollo Appleyard, in *Electrical Communication* for October, rightly includes him in his biographies of the pioneers of electric signalling. Chappe, who was born in 1763 and died in 1805, endeavoured to replace acoustic signals by electric signals At that time, however, the insuperable difficulty was how to insulate the wire Chappe was educated for the Church, but when the Revolution came he devoted himself to the Republic. From 1793 to the end of his life he did valuable public service, semaphore lines operating on his method and with his code connecting Paris with many towns in France.

CHAPPE's only recompense as an inventor was the satisfaction of having served his country. He did not escape cruel annoyance by those who claimed to have anticipated his successful devices. In 1804, Napoleon demanded the immediate establishment of a telegraph service between Paris and Milan through Lyons. The work proved too heavy for him and shortened his life. Ultimately there were 58 semaphore stations between Paris and Lyons. Trees which interfered with the line of vision were cut down and their owners indemnified. Chappe was fully aware of the extent to which the general principles of his devices had been praised by the ancients. The value of his work lay in the adaptation of these principles to the needs of his time. His mechanism was designed to secure the greatest visibility, strength, lightness, durability, and ease of operation, and his successful methods were a great boon to several European countries until the invention of the electric telegraph by Wheatstone in 1837 made some of them antiquated.

AT a meeting of the Newcomen Society held on Nov. 20, Mr. Rhys Jenkins read a paper on "The Art of Water Drawing", the title being taken from a work published in 1660 apparently written by one R. D'Acres, whose name is attached to the preface. The book is extremely rare, and in view of the interest

ing way the author treated his subject, the Society proposes to reprint it as one of its "Extra Publications". A striking feature of the book is the systematic way in which the pumping machine is analysed into prime mover, transmitting mechanism, and operating member, while D'Acres gives evidence that he understands the action of the pressure of the atmosphere in forcing water into a vessel containing a partial vacuum. He goes on to suggest, indeed, the use of fire for the raising of water, and describes an apparatus into which water can be drawn through the cooling of hot gases within it. Whether he made such an apparatus is not known. Mr. Jenkins gave some interesting information regarding the use of bucket gins, that is, the chain of buckets or chain of pots once in common use in Great Britain, suction pumps, force pumps, and other appliances of Tudor and Stuart times, and referred to some of the earliest examples. According to the "Oxford English Dictionary", no trace of the name 'pump' occurs before the fifteenth century, for though remains of Roman pumps have been found, such things went out of use with the coming of the Saxons. During the meeting, it was announced that Mr. L. St. L. Pendred has consented to continue as president for a second year, and that the Society now has 248 individual members, besides 57 institutions which subscribe as members.

MR. ERIC MACLAGAN, director and secretary of the Victoria and Albert Museum, South Kensington, has been elected an honorary member of the Yorkshire Philosophical Society.

FURTHER correspondence concerning the appearance of the comma butterfly in England has reached us (see also NATURE, Oct. 26, p. 653, and Nov. 16, p. 770). Mr. E. J. Machin records its capture at Tettenhall, South Staffordshire, on Oct. 18 last, and Mr. R. L. Williams states that a specimen was taken in the grounds of the Biological Field Station of the Imperial College of Science, Slough, Bucks, on Sept. 24.

THE Principal Trustees of the British Museum have appointed Mr. J. Ramsbottom, at present deputy keeper in the Department of Botany, to be keeper of the Department on the retirement of Dr. A. B. Rendle on Jan. 19 next. Mr. G. J. Arrow has been appointed deputy keeper in the Department of Entomology.

AT the annual general meeting held on Nov. 14 of the London Mathematical Society, the following officers were elected:—*President*: Prof. S. Chapman; *Vice-Presidents*: Prof. W. E. H. Berwick, Prof. P. J. Daniell, and Prof. E. H. Neville; *Treasurer*: Dr. A. E. Western; *Librarian*: Prof. H. Hilton; *Secretaries*: Prof. G. N. Watson and Mr. F. P. White; *New Members of Council*: Mr. T. W. Chaundy, Prof. G. H. Hardy, Prof. H. Levy, and Prof. L. J. Mordell.

THE Williams Prize of the Iron and Steel Institute, of the value of 100 guineas, has this year been awarded by the Council to Mr. William E. Simons, assistant blast-furnace manager at the Cardiff Works of Messrs. Guest, Keen, and Nettlefolds, Ltd., in consideration of his paper on "The A.I.B. Sinter Plant at the Works of Guest, Keen, and Nettlefolds, Limited," which he presented at the last annual meeting of the Institute in London.

AT the annual general meeting of the University of Durham Philosophical Society, held on Oct. 31, the following officers were elected:—*President*: The Hon. Sir Charles A. Parsons; *Vice-Presidents*: Prof. Masson, Mr. Wilfred Hall, Sir William Marris, Dr. Morrow, Dr. Smythe, Prof. Harrison; *Hon. Secretary*: Mr. W. M. Madgin, Armstrong College, Newcastle-upon-Tyne; *Hon. Treasurer*: J. W. Bullerwell, Armstrong College, Newcastle-upon-Tyne.

ON Oct. 1, Sir Frederic G. Kenyon opened at Hull the Mortimer Collection of Prehistoric Antiquities, which was presented to the Corporation by Col. G. H. Clarke, and has now been given a permanent home in the Old Art Gallery of the City Hall. There are few museums, Sir Frederic said, which put the people so closely in touch with prehistoric man as the Mortimer Museum. The objects are clearly recorded and admirably displayed. Some idea of the extent and scientific value of the collection may be gathered from the fact that Mr. Mortimer excavated about 350 burial mounds, from the Bronze Age to Roman and Saxon times, and preserved every object found in them. In addition, there are many Neolithic objects found unassociated with burials in various parts of the world.

THE Department of Zoology of the British Museum (Natural History) has recently received a fine example of the common porcupine (*Hystrix cristata*) mounted in a defensive attitude with its spines erected, from the trustees of the Rowland Ward Bequest; while Mr. C. D. Soar has presented to the Department a collection of nearly 600 slides of microscopic preparations of water-mites, forming the material described in the standard monograph, "British Hydracarina", by Mr. Soar and Mr. Williamson, published by the Ray Society (1925–29, 3 vols.). Through the generosity of Mrs. M. E. Eaton, the Department of Entomology has received the collection of Psychodidæ (moth-flies) formed by her late husband, the Rev. A. E. Eaton, and including more than 1800 pinned specimens and about 200 microscope slides. It is probable that the Eaton collection is the largest and most important in existence, including as it does, in addition to a complete series of the known British species, much material from Switzerland, Algeria, Madeira, the Canary Islands, and elsewhere. It is hoped that it may be possible to publish some parts of Mr. Eaton's manuscript notes on the group. A recent addition to the Department of Geology is a cast and enlarged model of the tooth of the fossil man *Sinanthropus pekinensis* from the Pleistocene of China. Many specimens of minerals and rocks recently collected in Northern Rhodesia and South-west Africa have been added to the mineral collection.

A CATALOGUE (No. 10) of some 500 second-hand books relating to botany and zoology has been received from Mr. J. H. Knowles, 92 Solon Road, S.W.2.

WE have received from Messrs. W. and G. Foyle, Ltd., 119 Charing Cross Road, W.C.2, a copy of their

latest catalogue of books relating to medicine and allied sciences.

Messrs. Francis Edwards, Ltd., 83 High Street, Marylebone, W.1, have added to their interesting series of catalogues No 519, consisting of nearly 600 titles of books, maps, views, and MSS. concerning the West Indies.

Applications are invited for the following appointments, on or before the dates mentioned —A demonstrator in civil and mechanical engineering in the Department of Engineering of the University of Leeds—The Registrar, The University, Leeds (Dec. 2) A clinical assistant in the Department of Physio-Therapy of St. George's Hospital—The Dean of the Medical School, St George's Hospital, S.W.1 (Dec. 7) A lecturer in physics at the Northampton Polytechnic Institute—The Principal, Northampton Polytechnic Institute, St. John Street, E C 1 (Dec. 10). A woman lecturer in geography at the Leeds Training College—The Principal, Training College, Leeds (Dec. 10). A principal of the Norwich Technical College—The Secretary of Education, 41 St Giles Street, Norwich (Dec. 10). A director of the Marine Trades School, Suez, under the Egyptian Ministry of Education—The Under Secretary of State, Ministry of Education, Cairo (Dec. 10). A glass blower in the Department of Chemistry of the University of Cape Town—The Secretary to the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (Dec. 11) A petroleum technologist to the Government of Trinidad—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, S W.1 (Dec. 20) A professor of social biology at the London School of Economics—The Academic Registrar, University of London, South Kensington, S W 7 (Jan. 23). A Martin White professor of sociology at the London School of Economics—The Academic Registrar, University of London, S W 7 (Jan. 24). A head of the Department of Mechanical and Structural Engineering and Building of the Borough Polytechnic Institute —The Principal, Borough Polytechnic Institute, Borough Road, S E 1 A lecturer in mathematics and geography at St Gabriel's Training College for Women—Miss K. T Stephenson, St Gabriel's College, Cormont Road, Camberwell, S E.5 A laboratory assistant in the soil chemistry laboratories of the Agricultural Research Station, Amani, Tanganyika Territory—The Crown Agents for the Colonies, 4 Millbank, S.W.1 (quoting M/1797). A lecturer in botany in the University of Reading—The Registrar, The University, Reading Heads of the pathological and botany divisions of the Rubber Research Institute of Malaya—The Secretary, London Advisory Committee, Rubber Research Institute of Malaya, 2/4 Idol Lane, Eastcheap, E C.3.

## Our Astronomical Column.

**Changes on Jupiter.**—The planet Jupiter will be in opposition to the sun on Dec. 3, and promises to exhibit some very interesting phenomena to observers. Mr A. Stanley Williams, Rev. T. E. R Phillips, and others have reported the appearance of a long stream of dark spots in the region immediately south of the north temperate belt of the planet. On Nov. 16 the spots extended over about half the circumference, for Mr. Phillips found that they occupied 5 hours in crossing the central meridian. This outburst of spots has appeared in the same latitude and presents a similar aspect to that shown by a remarkable train of spots which attracted much attention in October and November 1880. The latter objects gave a rotation period of $9^h$ $48^m$ and formed a new dusky belt on the planet in 32 days. They were among the swiftest markings ever detected on the Jovian surface. The present revival of similar details is very suggestive of repetition, for the spots at present visible are travelling with great rapidity of movement and complete a rotation in about $9^h$ $49^m$. They are being attentively watched in order to determine whether or not they become transformed into a new belt as occurred with the markings of 1880

**The Binary Star 70 Ophiuchi.**—It has long been known that the discordances between theory and observation in the distances and position angles of this star are of a somewhat systematic nature; some of the orbit computers have considered that there was evidence of a third unseen component disturbing the motion of the others; an alternative explanation was that the discordances arose from systematic errors in the observations, depending on the inclination to the vertical of the line joining the stars. It is known that some observers have personal errors of this nature, and R. Tschilschke examines in *Astr. Nach.*, No. 5664, whether the discordances can be explained in this way He concludes in favour of the existence of a third mass from the fact that the discordances have a different period from the period of revolution of the visible pair; he finds 89·09 years for this, but about 64 years for the discordance. He concludes also that the node shows a yearly change of some 2°, indicating that the third body moves in a plane different from that of the visible system.

**The Star-cloud in Scutum**.—*Lick Bulletin*, No. 416, consists of an examination by C. J. Krieger of the distance and depth in the line of sight of the galactic star-cloud in Scutum (now generally included in Aquila). The centre of the cloud is at about R.A. $18^h$ $43^m$, S. Decl. 7·6° (equinox of 1900) The spectral types of the brighter stars were obtained by slitless spectrograms; the photographic magnitudes by comparisons with the north polar sequence, the colour indices by photographs with colour filters. The cloud is approximately 6° by 8° in angular area, its mean distance is determined as 2800 parsecs, which makes its mean diameter in a direction perpendicular to the line of sight 350 parsecs; the depth in the line of sight appears to be greater, being between 500 and 1000 parsecs. The relative luminosities of the different spectral types are the same as in the neighbourhood of the sun, but the density of distribution of dwarf stars is considerably greater. There is concluded to be a region of low star density between the solar cluster and the Scutum Cloud. Other estimates of the distance of the cloud are: Seares, 7000 parsecs; Shapley, 4000 to 6000 parsecs; Kreiken, 1500 parsecs; Malmquist, 3400 parsecs. The mean is 4200 parsecs, or 1·5 times Krieger's estimate. The study of the distance of these galactic condensations is of interest for comparison between them and the condensations in the spiral nebulæ.

## Research Items.

**Mice and Evolution**.—Following a summary of recent results of the irradiation of animals by X-rays and its effect upon inheritance of characters, N. Dobrovolskaia-Zavadskaia has discussed his own experiments upon 35 breeding mice (*Biol. Rev. and Biol Proc Cambridge Phil Soc*, vol 4, October 1929, p. 327). In a progeny numbering about 3000, only two mutations were discovered, and these, having already been found apart from irradiation, are regarded as manifestations of pre-existing latent states brought to light under the influence of the rays. The rays can scarcely, therefore, be looked upon as a real cause of mutations, as has been alleged. On the results of these relatively few experiments, the author has the temerity to base a theory of evolution, a hypothesis of stable species with single changeable individuals, which are the source of new forms. This hypothesis conceives evolution to be based on three foundations: (1) Stability of existing species as the expression of the conservative principle of life, (2) variability of single individuals as the manifestation of the creative power in Nature; and (3) natural selection as the sifting out of the adapted species. We cannot comment on these conclusions in this note, but on general grounds we deprecate the building up of wide theories upon artificial experiments without any reference to the course of events in Nature. Although species are of the essence of the theory, the species of mouse experimented with here is not even named.

**Catgut and its Sterilisation**.—With the exception of antiseptic treatment, probably no procedure has advanced the practice of surgery more than the use of the ligature for tying the blood-vessels and controlling hæmorrhage. Many substances have been employed for the purpose, but catgut is usually the material to be preferred Catgut for surgical use should be sterile in the sense of being free from any bacterial contamination, yet flexible, strong, and absorbable in the tissues. The practical problems involved in producing such a material are the subject of a report by W. Bulloch, L. H. Lampitt, and J. H. Bushill, issued by the Medical Research Council (*Special Report Series*, No. 138; London: H.M. Stationery Office, 4*s* net). Prof. Bulloch contributes what must be the most complete modern account of the history and literature of the whole subject, as well as the results of thousands of sterility tests and experiments on methods of sterilising Dr. Lampitt and Mr. Bushill deal with the physical and chemical properties of the sheep's intestine (from which 'catgut' is made) and its manufacture into sterile ligatures for surgical use. Prof. Bulloch finds that much commercial surgical catgut is not sterile, and that many of the sterilising processes recommended are inefficient. It is of interest that the last method devised by Lord Lister, who studied the subject for forty years, which consists in the use of chromium sulphate and mercuric chloride, yields a sterile product. Prof. Bulloch finds that a 1 per cent aqueous solution of iodine and potassium iodide will infallibly sterilise the most contaminated catgut if applied for not less than eight days, and is the best agent to employ on a commercial scale. Messrs. Lampitt and Bushill show that the iodine process yields a satisfactory ligature provided certain conditions are observed and precautions taken during manufacture.

**Development of Mosquito Larvæ**.—Dr. Malcolm E. MacGregor (*Parasitology*, vol. 21, 1929) has described observations on the significance of the hydrogen ion concentration in the development of mosquito larvæ, especially those of *Ædes argenteus* By gradually eliminating one and another of the interacting factors he has been able to demonstrate (*a*) that if the $p$H of the normal environment is changed the development of the larvæ is adversely affected; (*b*) that under bacteriologically sterile conditions the foregoing statement is no longer true, and (*c*) that consequently the acid or alkaline reaction of the medium, within ordinary limits, has no direct effect upon the development of the larvæ An alteration in the $p$H often brings about a change in the biological group associations and the abnormal dominance of factors unfavourable to a particular species of larvæ The larvæ of certain species show a restriction to waters exhibiting a $p$H index within a definite short range, and hence the $p$H index is often a trustworthy indication as to whether the chemical and biological group associations will favour or preclude successful development of such larvæ. The author states that of the different artificial food stuffs nothing has been found to suit the larvæ of *Ædes argenteus* so well as bread, and he describes the technique for the production of successful cultures of larvæ and pupæ under bacteriologically sterile conditions. The phase of 'suspended development' of the larvæ of many species of mosquitoes is found to have its probable explanation in the temporary or complete disappearance of micro-organisms on which the conversion of the organic materials of the environment to a suitable larvæ diet depends

**Parasitic Roundworms in Sheep**.—The Ministry of Agriculture and Fisheries has recently issued two clearly written leaflets on parasitic roundworms in sheep. The first (No. 75) gives an account of the twisted wire worm (*Hæmonchus contortus*) which occurs in the fourth stomach of the sheep, and the second (No 304) deals with the common lung worms of cattle, sheep, and goats, causing 'husk' or 'hoose'. The life-history of the respective worms so far as it is known is concisely described, and will undoubtedly "assist the direction of intelligent effort towards suitable measures of control". These measures and curative treatment are briefly described.

**Trypanorhynchid Cestodes from Ceylon and India**.—The first part of a monograph by Dr. T Southwell on Cestodes of the order Trypanorhyncha from Ceylon and India is published in *Spolia Zeylanica*, vol. 15, part 3, 1929. An extensive historical survey of the literature of the order is followed by the author's proposed classification into three families with six certain genera and one of uncertain position, and by a description of each of the species. A list is given of the species—about three dozen—recorded from India and Ceylon and of their respective hosts. A note is added on larval cestodes collected in large numbers from the umbrella of a rhizostomous medusa in the Chilha Lake. At the anterior extremity of the larva is a deep pit the base of which—where the head or scolex would later develop—is thickened. These are plerocercoid larvæ but are not identifiable further. Dr. Southwell states that no cestode larvæ have been previously recorded from medusæ.

**A Four-Rayed Clypeaster**.—Mr. Iwao Taki describes an unusual abnormality in this specimen of *Clypeaster japonicus* ("Note on a 4-rayed Specimen of *Clypeaster japonicus* Döderlein". *Memoirs of the College of Science*, Kyoto Imperial University, Series B, vol. 4, No. 2, article 6, 1929.) It was found on the shore close to the Seto Marine Biological Laboratory, Seto, Prov. Kii, after a heavy storm. Several normal

individuals were obtained at the same time Compared with these latter the abnormal specimen, which is immature, has a much rounder outline, the test is higher, the number of ambulacral pore pairs smaller, and the outline of the petals oval with an obtuse distal part. The four rays are repeated in the madreporite, which is nearly square with only four genital pores, situated at the four corners One of the petals is open showing it to be the anterior The remaining three, therefore, represent the other four rays of a normal specimen From the number of pore-pairs it is deduced that one of the posterior petals is missing, and that the tetramerism is brought about by the abortion of the right posterior ambulacrum and adjacent interambulacra.

**Nets for Plankton Research**—In a recent publication by the International Council for the Exploration of the Sea ("Vergleich der Fangfahigkeit verschiedener Modelle von Plankton-netzen". *Rapports et Procès-Verbaux des Réunions*, vol 69, September 1929 (København: Andr Fred. Høst et Fils) Cl Kunne gives the results of some quantitative tests which have been made with three types of nets, Hensen's egg-net, the Nansen net, and the standard net of the International Council. He finds that while the Nansen net and the Hensen net are rather similar in their catching powers, the former catching about 90 per cent as much as the latter, the standard net, on the other hand, falls far short in efficiency, catching only one-tenth of the material that the Hensen net does. Moreover, this is not due so much to the lesser dimensions of the opening of the standard net, but rather to its construction. It seems probable that the netting inserted at the front tends to constrict the virtual opening of the net where it joins the silk, and the throttling rope may also help in this at times The question is an important one and should be settled now that there is a tendency more and more to standardisation of method in order that results may be comparable. The author favours the Hensen net for its convenience in sea work, in spite of its cumbrous size.

**Nitrogen Metabolism of Virus Diseased Plants.**—The nitrogen metabolism of healthy and spiked sandal leaves has been studied by N. Narasimhamurthy and M. Sreenivasaya, and their results have been published as Part 6 of the "Contributions to the Study of Spike-disease of Sandal (*Santalum album* Linn.) in Vol. 12 A, Part 10, of the *Journal of the Indian Institute of Science*, pp. 153-163. They report a greater content of total nitrogen (on a dry weight basis) in spiked leaves than in healthy leaves where a leguminous host is absent, whilst little difference can be detected when the latter symbiont is present. There is, however, in all cases an increase in total water-soluble nitrogen, basic nitrogen, and total amino nitrogen, and a decrease in the nitrate nitrogen in the diseased leaves, when compared with healthy leaves, relative to either dry weight or to total nitrogen Comparisons are drawn with the nitrogen contents of several plants attacked with virus diseases which usually show no decrease in total nitrogen content as a result of the disease.

**Industrial Development of Saskatchewan**—The province of Saskatchewan in the Dominion of Canada is chiefly known as a great wheat-producing area, but the development of its natural resources in other directions is proceeding apace, and it is apparent that before very long there will be an industrial activity corresponding in many respects to that of the provinces of eastern Canada. A report issued by the Natural Resources Division of the Saskatchewan Department of Railways, Labour, and Industries, for the fiscal year ended April 30, 1929, shows that during the past twelve months much attention has been given to the establishment of the lignite briquetting industry near Estevan, and to mineral development in that large area of Saskatchewan which lies within the boundary of the two million square mile Pre Cambrian Shield Mention is made in the report of the exploitation of the Province's non-metallic mineral resources, etc., its clays, sodium sulphate deposits, and volcanic ash, special attention being given to the marketing of sodium sulphate, the importance of which to the Canadian pulp and paper industry is considerable

**The Eruptions of Mayon Volcano.**—In *The Philippine Journal of Science* for September last, L. A. Faustino describes Mayon Volcano and its eruptions, with special reference to the great outburst that took place last year The volcano is a cinder cone with venticular lava flows, and its profile follows very closely the hyperbolic sine curve discussed many years ago by Becker Surface indications point to only one orifice, and if there have in the past been subordinate openings, they have since been hidden. None appeared in 1928 The original vent broke through a Tertiary basement in late Tertiary or early Quaternary time, and Mayon is to-day the most active cone in the Philippines The ejected materials are of porphyritic basaltic composition and they have repeatedly smoothed the irregularities caused by erosion and weathering, thus maintaining the almost perfect symmetry and form of the cone Since the destructive eruption of 1814, twenty-eight well-defined eruptions have been recorded, the longest period of relative quiescence being from 1900 to 1928. The eruptions can be described in terms of the sequence recognised by Perret in his well-known description of the Vesuvius eruption of 1906. In the case of Mayon, the luminous, *liquid lava* phase is of shorter duration than at Vesuvius; the intermediate, *gas* phase, characterised by vapours and gases with but little ash, is longer; and the dark, *ash* phase is marked as usual by a preponderance of ejected ashes.

**Late Cretaceous and Tertiary of New Zealand.**—In his presidential address to the Geological Section of the Fourth Science Congress of New Zealand, Dr. J Henderson gave a detailed series of correlations of the Tertiary and late Cretaceous deposits for seven characteristic areas of New Zealand (*Trans. and Proc N.Z. Inst.*, **60**, pp. 271-299; 1929). The strata are divided into three groups on diastrophic grounds. The first, following the Hokanui deformations, when New Zealand was more extensive than now and diversified with a great chain of mountains of which the present axial highlands are the roots, extended from the Albian to the close of the Eocene. Widespread movements then occurred, and basic rocks were erupted in many districts. The resulting elevation, however, was not great, and base-levelling reached its climax during the succeeding Ototaran or Oligocene period. In the Miocene, the andesitic lavas of Auckland and Hauraki were poured out. These seem to have relieved the crustal stresses in part, for the post-Ototaran movements are found to be more pronounced in the South Island, where volcanic outbursts were less active. During the Pliocene, the Kaikoura movements reached their climacteric. Since then the Castlecliff beds and their correlatives have been laid down, and the basaltic vents of Whangarei have continued intermittently. The paroxysmal rhyolitic outbursts of the Rotorua-Taupo region began a little later than the first emissions of basalt. The published address contains valuable correlation tables and a full bibliography.

**Crystal Structure of Ice.**—An elaborate investigation of the crystal structure of ice, now of importance in many connexions, is described by Dr W H Barnes in the November number of the *Proceedings of the Royal Society* (pp 670-693). The older data for this are conflicting, and even now the possibility cannot be ruled out that, quite apart from high pressure modifications, different forms may exist under slightly different conditions. Dr Barnes's results, however, which are based upon the interpretation of X-ray diffraction photographs taken by various methods at the Davy-Faraday Research Laboratory, show that the space group in the specimens studied by him was one of the two known as $D_{6h}^4$ (dihexagonal bipyramidal) and $D_{3h}^4$ (ditrigonal bipyramidal), with the probability in favour of the former Photographs taken by the powder method also failed to reveal any change in structure between the temperatures of standard melting ice and of liquid air. Four molecules go to build up each unit cell, and it is probable that the lattice is ionic.

**Melting-point of Palladium.**—The highest standard point in the thermometric scale which can be measured conveniently with the gas thermometer is the melting-point of gold, 1063° C Above this, recourse is usually made to radiation thermometry, with for technical purposes an agreed value for the radiation constant ($c_2$). It is, however, useful to have other higher fixed points, and of these the most important is the melting-point of palladium. One determination of this was reported in the *Bureau of Standards Journal of Research* for May of this year, yielding the value 1554°. A second determination, made at the National Physical Laboratory by F. H. Schofield, is described in the *Proceedings of the Royal Society* for October, and gives the temperature as 1555°. Older determinations, made at the Physikalisch-Technische Reichsanstalt in 1919 (1556°), and at the Nela Laboratories in 1920 (1557°), are also in remarkably good agreement with the new numbers, and it thus seems probable that the agreed value of 1555° which has been taken as the melting-point for the purposes of the International Temperature Scale cannot be in error by more than 2° It is an interesting fact that Prof. Callendar obtained a value only five degrees below this in 1899, working with a resistance thermometer of platinum, and extrapolating from the boiling-point of sulphur.

**Measurement of Radioactivity.**—The new electrical counter for α-particles and β-particles which was described by Prof Geiger and Dr. W. Müller last year is so extremely sensitive to weak radiation that it could be used immediately to demonstrate the radioactivity of potassium, and has since been applied to the study of the cosmic rays. An investigation of its utility in the measurement of radium preparations has now been made at Prof. Geiger's instigation, and is described by H. Neufeldt in the issue of the *Physikalische Zeitschrift* for Aug 15. The counter employed was of special design, and could, if desired, hold the radioactive preparation internally, the strength of the latter being measured by the secondary β-rays produced in the counter by the γ-radiation. Quantities of radioactive material equivalent to $10^{-8}$ mgm. radium could be measured in this way, as compared with about $10^{-4}$ mgm. with the most refined of the older methods. The precision of the measurements was about ten per cent, and the only important disadvantage inherent in the use of the instrument appears to be the long time—of the order of several hours—required to obtain sufficient auxiliary data to allow for the large number of particles of uncontrollable origin which are recorded by it, due very largely to the cosmic rays and the radioactivity of the material of the counter itself.

**Viscosity of Solutions.**—Although much experimental work on the effect of concentration on the viscosity of solutions has been carried out, it has been found difficult to represent the results by means of equations. In the October number of the *Journal of the American Chemical Society*, G. Jones and M. Dole describe some very accurate measurements of the viscosities of barium chloride solutions at 25° over a range of concentration of 0 005 to 1 0 molal. They find that the fluidity (1/viscosity) can be represented by an equation of the form $\phi = 1 + A\sqrt{c} - Bc$, which also fits other data with proper values of $A$ and $B$ The term in $\sqrt{c}$ was suggested by the Debye and Huckel formula for electrolytes, and since $A$ is always negative for electrolytes it is suggested that it represents the 'stiffening effect' on the solution of the electric forces of the ion atmosphere. For non-electrolytes $A$ is zero. The value of $B$ may be positive or negative.

**The Active Principles of Pyrethrum Flowers.**—The use of pyrethrum flowers, or an extract in the form of liquid insecticides, has increased considerably during the last five years, and some method of determining the amount of active principles in them has been required In 1916, Staudinger and Ruzicka found that the two active principles of pyrethrum flowers were pyrethrin I and pyrethrin-II, which were shown to be esters of a ketone-alcohol, pyrethrolon, with two acids, chrysanthemum monocarboxylic acid and chrysanthemum dicarboxylic acid methyl ester, to which they were able to attribute structural formulæ. In the October number of the *Journal of the American Chemical Society*, Gnadinger and Corl describe the isolation of pure pyrethrin-I and -II from Japanese pyrethrum flowers They then worked out a method for the determination of these principles in the flowers by means of the reducing action on alkaline copper solution as compared with that of dextrose, and in this way were able to use much smaller quantities of material than were required in previous methods. The percentages found ranged from 0 40 to 1 21.

**A Novel Evaporating Plant.**—In the *Chemiker-Zeitung* for Oct. 16 is described a novel form of evaporating plant for which many advantages over other types are claimed. The principle involved is the distribution of the liquid into extremely thin layers, which are allowed to flow over funnel-shaped heating surfaces. The time required for the vaporisation of a given bulk of liquid is thus enormously reduced and the vapours can be removed rapidly without encountering the resistance of a column of liquid. The process is continuous, and since the liquid is also kept constantly in motion, there is no danger of superheating, foaming, or bumping. The heating units can be built up into columns of varying heights according to the degree of concentration of liquid required, and by means of separate steam-pipes they may be heated to different temperatures, so that when the evaporator is used for the distillation of oils a preliminary separation into fractions is effected. Fractionation may be completed by combining the evaporator with suitable dephlegmators and condensers. The apparatus is also well adapted for the concentration of solutions in which prolonged heating is apt to induce chemical decomposition; when once regulated for a particular operation, very little supervision is needed The efficiency of the evaporator may be judged from the fact that 80-90 kilograms of water can be evaporated per square metre of heating surface in one hour without using a vacuum pump. The apparatus is patented and manufactured by Messrs. Zahn and Co, Ltd., of Berlin

## Fuel Research.[1]

THE Report of the Fuel Research Board for the year ended Mar. 31, 1929, is remarkable for its range of subject matter, and it is only by selective treatment that a short notice like this can be made anything more than an enumeration of its contents.

The first part of the report, by Sir Richard Threlfall, the chairman, does not limit itself to an account of the activities of the Board, but deals also with other happenings in the world of fuel which may be regarded as relevant. The opening sentence states a wholesome truth which cannot be too strongly emphasised in these days, when the pursuit of what is known as rationalisation may lead to over-centralisation if it is not carried out with care, discrimination, and sober judgment. The sentence proclaims the difficulty (and might have said impossibility) of one research organisation dealing adequately with the many and complicated problems involved in the study of the coal resources of Britain and their utilisation, and welcomes the increasing attention given to fuel research, both by individual firms and by industrial organisations. Notice is also given to a particular recommendation by the National Fuel and Power Committee, which is not content with the prosecution of research alone, but insists upon the necessity for the application of the results of research and the consequent necessity of employment on the executive side of industry of more men trained as fuel technologists.

Another recommendation of the National Fuel and Power Committee is noted, that the thermal system of charging for gas (introduced by the Gas Regulation Act of 1920, on the recommendation of the Fuel Research Board) should be regarded as having proved its value, and be made compulsory, except for very small undertakings. This recommendation has been embodied in the Gas Undertakings Act, 1929.

The physical and chemical survey of the national coal resources is reported upon as having progressed steadily, and with the appointing of a committee to deal with the South Wales area, the organisation now covers coalfields producing 85 per cent of the coal raised in Great Britain. There is so much that might be done on such a survey, with its many possible ramifications indicated in the report, that a wide vista of usefulness is opened out for the Fuel Research Board, if it is to deal adequately with this part of its work. The survey once begun leads naturally to the operations of other committees (such as the Coke Research Committee, formed at the instigation of the National Federation of Iron and Steel Manufacturers), which deals with the properties of coal mined in certain areas for various industrial uses.

All this has led to a realisation of how comparatively little is known even to-day on many of the most fundamental and elementary things connected with coal and its carbonisation; and the Fuel Research Board is assisting workers at the universities in their endeavours to extend and strengthen the scientific foundations on which the structure of the fuel industries must be based.

Quite topical is the reference to the use of pulverised fuel, both ashore and afloat, and to work which the Fuel Research Board is itself carrying out on the interesting subject of burner design for this purpose, on the principle of so relating the movements of air and the solid particles of fuel that maximum efficiency of contact and rapidity of combustion can be secured. It is to be hoped that the Board will be able to turn its attention to the problem of dust emission from plants using pulverised coal, which promises to become very serious as this method of use is extended in scale.

The largest section of the report is contributed by Dr. C. H. Lander, the Director of Fuel Research. He deals with many subjects, but probably the one to which the most general interest will attach is that of low temperature carbonisation. If one were to choose the branch of work in which the Fuel Research Board has been of the greatest public service, it would surely be either this, or the formulation of the recommendations on which the Gas Regulation Act of 1920 was based. Low temperature carbonisation should, however, take first place, since the Fuel Research Board has not only interested itself in the subject by the examination and testing of quite a number of proposed processes embodying different ideas and types of construction, but also has carried out useful research work and informative experiments by its own staff at the experimental station at Greenwich. The time has now arrived when a limited number of the numerous processes and plants projected for carrying out low temperature carbonisation have reached the stage of full scale technical working and commercial trial. Some of these engage the attention of Dr. Lander in this report, particularly the setting of vertical cast-iron retorts at the Richmond Gas Works, erected by the Gas Light and Coke Company to the general design developed earlier at the Fuel Research Station.

Dr. Lander undertakes a two-page review of the general position of low temperature carbonisation as deduced from the experiments and observations of the Board. It is a summing up, characterised by knowledge, fair-mindedness, and caution, and is neither condemnatory nor eulogistic of any particular process or of the low temperature system as a whole.

So far as the summary can itself be summarised, it points to the necessity for considering every individual undertaking on its merits with due regard on one hand to the nature of the coal it is proposed to treat and the available supply, and on the other to the outlets for the coke, tar, and gas. Of equal importance are the questions of maintenance and depreciation of the plant, which must take a considerable time to ascertain unless the life is short and replacement expenses heavy. Then again come the factors which govern the prices of different classes of coal and the saturation point in the markets for the products. It seems likely that there are situations where low temperature carbonisation of coal can be made to pay, but the incidence of the factors mentioned above has to be considered carefully in choosing a plant and a locality for its installation.

Some experiments are described on the hydrogenation of coal. They are too few in number to allow definite deductions at this stage, but are undoubtedly promising and very interesting from their possible bearing on the constitution of coal. It is reported that by the action of hydrogen under pressure on the Bergius principle, but not carried so far, "a non-caking coal has been converted into solid products with strong caking power, and further experience has shown that carbonaceous materials ranging from cellulose and wood to anthracite, and including [illegible] types of coal and lignite, can, by controlled treatment with hydrogen under pressure, be converted [illegible] material which on carbonisation, yields a [illegible] coherent coke".

[1] Department of Scientific and Industrial Research. Report of the Fuel Research Board for the year ended 31st March 1929; with Report of the Director of Fuel Research. Pp. viii+127. (London: H.M. Stationery Office, 1929.) 2s. net.

In high temperature carbonisation, the principal work of the year has been a study of the effect of size of coal on the working of horizontal and vertical gas retorts, being a continuation on a larger scale of work already carried out at the University of Leeds for the Gas Investigation Committee of the Institution of Gas Engineers. "The general result of the investigation is to confirm that the influence of size of the coal charged is greater with vertical than with horizontal retorts, and that with vertical retorts those variations offer a means of controlling, to some extent, the yields and qualities of the products to suit the needs of particular circumstances In particular the increased yields of tar may be important."

Among other subjects receiving notice may be mentioned the composition of low temperature tars, combustibility, 'shatter' tests, and reactivity of coke, the effect of oxidation on the coking properties of coal, briquetting, the water gas process, the use of coke for domestic purposes, the heating requirements of a house, an interesting method of expressing fuel consumption in internal combustion engines, and various methods for sampling and analysis

John W Cobb.

## The Atlantic Earthquake of Nov. 18, 1929.

An earthquake that could break a dozen deep-sea cables, that could give rise to destructive sea-waves on the Newfoundland shores, and to a shock felt along 940 miles of the American coast, must clearly have been one of unusual strength

In Nova Scotia, the shock was felt severely in Halifax, Yarmouth, and other places. In Windsor, chimneys were thrown down At St. John's (N.F.) the shock was slight, but all along the New England coast, as far as Boston, it was distinctly felt. At the time of the earthquake the White Star liner *Olympic* was about 300 miles from the spot at which cables were broken The captain reported that, at 3 30 P M on Nov 18, he felt the vessel suddenly quiver, as though she had cast off a propeller blade, and this movement was followed by vibrations lasting for two minutes. The ship was found to be undamaged and there was no wreckage in its wake.

Two and a half hours after the shock was felt, sea-waves flowed up the southern shores of Newfoundland. In Long Harbour, which lies at the head of a narrowing inlet, fishing-booms and stages were damaged by the sea-waves, and 75 yards of roadway were destroyed. A wave, 15 feet in height, swept away several houses in the town of Burin and all the buildings on the water-front. Nine lives were thus lost in Burin and seventeen others at Lord's Cove and Lamalin. In the open ocean the waves must have been much lower, but it might be worth while to examine the mareograms obtained at the western ports of Great Britain for any traces of their passage.

A remarkable effect of the earthquake was the fracture of a large number of telegraph cables Of the twenty-two cables that traverse the central district, twelve were damaged, and ten of these cross the Atlantic The probable site of the breakages is said to be in Lat. 44° N, Long 57° W. The fractures, however, were not concentrated in one spot, for two of the Western Union cables were severed at a depth of 90 fathoms off the coast of Nova Scotia, while a third, belonging to the same company, broke at a depth of 900 fathoms. The exact positions of the fractures will throw light on the origin of the earthquake. It may be that all twelve sites will be found to lie along a straight line, as happened in 1884 with three cables on the south-eastern slope of the Newfoundland Bank. At the same time, it seems quite possible that the earthquake may have had a multiple origin and that a displacement not far from land was responsible for the strong shock felt in Nova Scotia. It is difficult otherwise to account for the damage at Windsor, slight as it was, this town being more than 300 miles from the spot assigned to the fractures. On the other hand, that the sea-waves originated at a distance from land of this order of magnitude seems to be indicated by the long interval that elapsed between the earthquake and the arrival of the waves.

That the disturbed area was one of great size is clear from the length of coast shaken As Boston is 700 miles from the spot above mentioned, it is possible that the disturbed area may have contained so much as 1½ million square miles, an area that has seldom been exceeded in earthquakes of the last fifty years

C. Davison.

## Oil-Pools and Fault-Zones.

The effect of faulting on oil accumulation, equally on oil dispersion, has always been a matter of added interest in working out subsurface conditions, probably because each new case studied presents some peculiar feature worthy of close investigation. So many circumstances enter into the consideration of fault-fields, that were a classification of these alone attempted it would result in a tabular scheme almost, if not quite, as large as those already in existence for other structures, and, moreover, just about as useless. Accumulations dominated by normal fault systems, as at Luling, Texas; by reversed faults, as at Whittier, California; by overthrust faults, as at the well-known McKittrick field, California; by the high factor of porosity in many fault-belt shatter-zones where adequately sealed; by the buffer action of solid bitumen resulting from inspissation of heavy oil along planes of dislocation: these are a few of the many possible expressions of fault-structure capable of influencing storage.

Probably the most difficult cases to elucidate, if not the most important from an economic point of view, are those pools either determined or to some extent controlled by low-angle overthrusting, with its concomitant network of subsidiary 'blatts', or by those thrust-faults in which curvature of the planes, when pronounced, complicates definition except under the most favourable conditions of full well-data As illustrative of the latter, Mr. Frank Reeves' survey of the Highwood Mountain oil-areas, Montana (*Bulletin* 806-E, 1929, United States Geological Survey), is worthy of note. The type of overthrust most commonly displayed in this region is that in which the surface-trace has a high angle of hade (or low dip) and flattens out in depth by mergence with the stratigraphic planes, so that it becomes, in fact, an almost horizontal thrust at some particular horizon in the area concerned.

Altogether an interesting contribution, although in this region the author concludes that the structures are not favourable to the ultimate location of oil and gas pools.

## University and Educational Intelligence.

CAMBRIDGE —The Vice-Chancellor has appointed Sir James Jeans to be Rede Lecturer for the year 1930.

Dr. R. A. Webb, Peterhouse, has been appointed University lecturer in pathology

The Raymond Horton Smith Prize for the year 1928-29 has been awarded to Dr. W. Shaw of St John's College

At Pembroke College Mr J M Whittaker has been elected into a fellowship and appointed lecturer and director of mathematical studies Mr. Whittaker obtained a first class in Part 2 of the Mathematical Tripos in 1927 and was awarded a Smith's prize this year

LONDON —Dr. G. A. Harrison has been appointed as from Oct. 1 last to the University readership in chemical pathology tenable at St. Bartholomew's Hospital Medical College In 1919-24 Dr Harrison was biochemist to King's College Hospital and lecturer on medical chemistry to the Medical School For the next two years he was biochemist at the Hospital for Sick Children, Gt Ormond Street, and since 1926 has been chemical pathologist to St. Bartholomew's Hospital and lecturer on this subject in the Medical College.

The following doctorates have been conferred: D.Sc. in chemistry on Mr. Harry Baines, for a thesis entitled "New Methods for the Analysis of Photographic Products and Raw Materials", and other papers. D.Sc. in physics on Mr. A. C. G. Menzies, for a thesis entitled "The Spectra of Fuses in the Ultra-violet and Schumann Regions", and another paper.

The Right Hon the Earl Beauchamp was installed as Chancellor of the University on Nov. 22.

H.R.H. PRINCESS MARY has graciously consented to open the new wing of the Battersea Polytechnic on Wednesday, Dec. 11, at 6.15 P.M. The additional accommodation provided will include a physical chemistry laboratory, a bacteriology laboratory, and two lecture rooms.

THE Institution of Chemical Engineers, Abbey House, Westminster, S.W.1, announces that application forms and particulars of its associate membership examination for 1930, together with the memorandum on "The Training of a Chemical Engineer", are obtainable from the Honorary Registrar at the address given. Completed forms must be returned by Dec. 23.

THE Chelsea Polytechnic directs special attention in its prospectus for the current session to its provision for the study of the scientific bases of some modern developments of industrial processes: in the department of physics, for example, technical acoustics and electricity for students of domestic science and demonstrations of electrical domestic appliances; in chemistry, preparation of compounds by industrial methods, technical analysis, including gas analysis, and the chemistry and microscopy of food and drugs, in natural science, the study of plant diseases, genetics, and industrial bacteriology. Its College of Science and Technology embraces mathematics, surveying, physics, chemistry, pharmaceutics, metallurgy, botany, geology, geography, mineralogy, zoology, anatomy, physiology, and hygiene.

## Calendar of Patent Records.

**December 1, 1671.**—On Dec 1, 1671, Prince Rupert was granted a patent for his new invention of "converting into steel all manner of edged tools, files, etc, forged and formed in soft iron, or any part of the said tools, after they are set, forged, and framed". The patent was to run from May 6, the date of an earlier grant which had been surrendered. In connexion with the patent, Prince Rupert was authorised in the following January to administer an oath to "the several workmen, artificers, and persons concerned in the said arts, neither directly nor indirectly to divulge or make known to any person whatsoever, except his Majesty the said arts or how they are used or with what instruments or materialls the same are made"

**December 1, 1898**—The telegraphone, an instrument which utilises the action of magnetism on a magnetisable wire for the recording and reproducing of sounds, was the invention of Valdemar Poulsen, the Danish engineer, who was granted a patent for the invention in Denmark, dated Dec 1, 1898. The apparatus has the advantage that the recording is not easily interfered with by subsidiary noises, and that the record can be 'wiped out' to enable the same wire to be used again by the simple process of demagnetising the wire Communications telephoned in the absence of the subscriber at the receiving station are recorded directly by the apparatus and may be given out by it to the subscriber whenever required. The apparatus was also used for the simultaneous transmission of speech to a number of subscribers

**December 2, 1856.**—Frederick Siemens' British patent for his regenerative furnace is dated Dec. 2, 1856, and though utilising ideas proposed by Robert Stirling in 1816, is one of the most important in the history of the steel industry The open-hearth method of making steel by the Martin-Siemens process, rendered possible by this invention, accounts for by far the larger proportion of steel made in the world to-day.

**December 2, 1893**—The pince-nez with pivoted nose-grips which can be expanded by the thumb and finger and allow the glasses to be placed easily on the nose with one hand was the invention of the French spectacle maker Jules Collet, and was first patented on Dec. 2, 1893, in Great Britain in the name of A. W. Newbold. The eyeglasses were originally sold under the name of 'Movillette' by Joseph Raphael, opticians, of London.

**December 3, 1901.**—The United States patent for the Gillette safety razor was applied for on Dec. 3, 1901, and granted in November 1904.

**December 4, 1806.**—The camera lucida, "an instrument whereby any person may draw in perspective or may copy or reduce any print or drawing", was the invention of William Hyde Wollaston, secretary of the Royal Society, and was patented by him on Dec. 4, 1806.

**December 6, 1679.**—To John Bellingham is due the introduction of the crown glass industry into England from France A patent was granted to him and Nicholas Hubin on Dec. 6, 1679, "they having been at great expences in bringing to perfection the manufacture of makeing Normandy window-glass in this kingdom which hath never yet been made here" and manufacture was started probably the same year at Bellingham's glass-house at Vauxhall A second patent for window-glass was granted to Bellingham in 1685, and by the end of the century crown glass was superior to Normandy glass and fetched a higher price than any foreign window-glass.

## Societies and Academies.

### LONDON

**Physical Society**, Oct 25.—**E. G Richardson** and **E Tyler**: The transverse velocity gradient near the mouths of pipes in which an alternating or continuous flow of air is established. A comparison is made of the alternating and direct flow of air near the mouths of tubes of various sections, by traversal of a hot-wire anemometer across the tube. In the alternating flow, a peak of high average velocity is found near the walls of the pipe, but in one way flow this annular peak is absent, the velocity falling continuously from the centre of the tube to within a short distance of the walls. The existence of a layer of laminar flow close to the walls, when the main body of air is in turbulent motion, is demonstrated.—**B. K. Johnson**: Resolving-power tests on microscope objectives used with ultra-violet radiation. An object of known regular structure and of variable interval is produced by projecting in the object-plane of the lens under test a reduced image of grating, the apparent line separation of which is varied by rotation of the latter; thus the line interval can be determined when resolution just ceases. The results show that the fused quartz monochromatic object-glass of numerical aperture 0 35, computed for and used with radiation of wave length 0 275 $\mu$, gives nearly twice the resolving power of a lens of similar aperture computed for and used with light of wave-length 0 51 $\mu$, while the fused quartz monochromatic lens of numerical aperture 1 2 has a resolving power 70 per cent higher than that of a well corrected object-glass of the same numerical aperture when used with light of wave-length 0 51 $\mu$.

**Geological Society**, Nov 6.—**H. Bolton**: Fossil insects of the South Wales Coalfield. A collection of nineteen fossil wings from the South Wales Coal Measures. Several are too fragmentary for determination of genus or species, or both, the remainder are referable to the Palæodictyoptera and Blattoidea. Palæontologically, the insect fauna of South Wales now shows relationships with the insect faunas of the Midland and Northern coalfields, and a close approximation to forms already known from the Coal Measures of Coalbrookdale (Shropshire), the Forest of Dean, and those of Kent, while several of the Hemimylacridian forms are identical with species described by Prof Pierre Pruvost from the Coal Measures of Pas-de-Calais (Northern France).—**A. R. Dwerryhouse** and **A. Austin Miller**: On the glaciation of Clun Forest, Radnor Forest, and some adjoining districts. The ice, derived originally from the highlands of Central Wales, filled first the depression now occupied by the valleys of the Rivers Ithon and Irfon to the west of the great line of escarpment extending from Kerry Hill on the north, by Radnor Forest and Aberedw Hill, to Mynydd Epynt on the south side of the Wye Gorge. As the ice accumulated, it first found escape by the valleys of the Severn and the Mule on the north, and by the Wye Gorge on the south. Gradually the level of the ice rose, until it overtopped the escarpment throughout its whole length, with, perhaps, the exception of the highest parts of Radnor Forest. The courses of the various glaciers thus formed are traced, and their effects on the drainage of the area are discussed.

**Royal Meteorological Society**, Nov 20.—**M. G. Bennett**: The physical conditions controlling visibility through the atmosphere. Visibility of any (large) object is a function of its brightness, and its contrast with the background. When dispersed matter is introduced between the observer and object, the apparent values of these variables are modified, and thus the visibility is altered. The modification is due to (1) screening or absorption, (2) glare or superposition of scattered light, (3) diffusion or reduction of definition. It was deduced from this that the obscuring power of a cloud of opaque (carbon) particles was mainly due to screening, whilst that due to water drops was due to diffusion. This should result in a certain difference between the falling off of visibility as an observer recedes from an object in a dry dusty atmosphere, as compared with a humid clean atmosphere. This difference was satisfactorily verified.—**L F Richardson**: The reflectivity of woodland, fields, and suburbs between London and St Albans. A record of measurements made from aeroplanes, using a white wedge photometer.—**Thora C. Marwick**: The electric charge on rain. Thunderstorm rain showed a high positive charge per cubic centimetre. Of the total quantity observed, 94 6 per cent was positively charged. Non-thunderstorm rain showed a lower charge per cubic centimetre and a lower percentage of positively charged rain, 79 5 per cent. Hail and rain mixed showed a large excess of negatively charged drops, only 39·4 per cent of the total quantity being positive. The charge per cubic centimetre was approximately the same as for non-thunderstorm rain.

### PARIS.

**Academy of Sciences**, Oct 21.—**E. Fournier**: The magnetic guidance of ships. Description of some improvements in apparatus for guiding ships electrically into a port, due to W. Loth.—**A Cotton**: The action of polarised light on certain photographic plates prepared with solutions of colloidal silver. Experimental studies on the Weigert phenomenon. Possible explanations are discussed: the hypothesis of a photoelectric effect is examined and rejected.—**E. L. Bouvier**: The classification and geographical distribution of the hemileucidian Saturnioidæ, sub-family Automeris.—**E. Mathias**: Contribution to the study of fulminating matter. The lowering of the surface tension by impurities.—**Charles Dhéré**: An arrangement permitting the compensation of the variations of the luminous intensity resulting, in the spectrum, from the mode of dispersion by the prisms.—**Eugène Slutsky**: The mean quadratic error of the coefficient of correlation in the case of series of non-independent proofs.—**E. Bompiani**: The tetrahedra invariant by projective applicability attached to the points of a surface.—**Chevalley**. The theory of ideals in infinite algebraic bodies.—**Jacques Chokhate**: The integrals of Stieltjes.—**Krawtchouk**. A generalisation of the polynomials of Hermite.—**Georges Valiron**: Meromorph algebroid functions of the second degree.—**Henri Cartan**: The differential with respect to log $r$ of the growth function $T(r; f)$.—**Podtiagume**: The regularity of functions with very rapid and very slow growth.—**D. Riabouchinsky**. The determination of a surface from the data that it bears.—**A. Lapresle**: A new principle for setting up large aerodynamical wind chambers.—**D. Rosenthal**: Verification of the resistance of soldered joints by an extensometric method without destruction of the coupling.—**Pauthenier** and **Mallard**: Contribution to the study of the cylindrical field in ionised air at the ordinary pressure.—**A Kling** and **A. Lassieur**. The hydrogen exponent of water. In earlier work the authors have found a value of 5·8 for the $p$H of pure water: this is now confirmed by an entirely different method.—**Auguste Le Thomas**: The influence of the structure of the casting on the alterations undergone at high temperatures. The structure of cast iron has a distinct effect on the formation of graphite.—**P. Job** and **Liou Oui Tao**. The cobaltiaquopentammonic and diaquo-

tetramminonic sulphates.—**Ch. Bedel**: The catalysis of the solution of silicon in hydrofluoric acid and the influence of tempering. The presence of certain substances which may be present as impurities in silicon increase the solubility of this element in hydrofluoric acid. On the other hand, this solubility is unaffected by the change into the $\beta$ and $\gamma$ varieties of silicon described by Koenigsberger and Schilling.—**L. Bert and M. Anglade**: A new method of synthesis of propylbenzene, of propenylbenzene and of their homologues. The synthetic method is general and is based on an unusual reaction, that of sodium and alcohol on compounds of the type $R \cdot CH = CH - CH_2 - O - R'$, in which R is an aryl group. Instead of the reduction product expected, a mixture of the hydrocarbons $R \cdot CH_2 \cdot CH_2 \cdot CH_3$ and $R \cdot CH = CH - CH_3$ is obtained in good yield. Details are given of two examples.—**Maurice Fontaine**: The action of high pressures on the respiration of the algæ. The consumption of oxygen by the alga diminishes as the pressure is raised, a result exactly opposite to that obtained with animals.—**Aug. Chevalier**: The invasion of the mouths of the Rivers Adour and Bidassoa by *Spartina glabra*.—**Raymond-Hamet**: Sparteine and hordenine.

ROME.

**Royal National Academy of the Lincei**: Communications received during the vacation.—**G. Armellini**: Measurements of double stars. The results are given of measurements of 56 double stars made with the Cavignato equatorial of the Royal Campidoglio Observatory (aperture 7 inches, focal length 2.383 metres, magnification about 600 diameters).—**G. Abetti**: Altitude of the chromosphere in 1928 and course of the present solar cycle. Measurements made at Arcetri indicate a general lowering of the chromosphere from 10.3″ in 1927 to 10.2″ in 1928, whereas those made at Madrid give the same value, 10.1″, in each of these years. Favaro and Taffara's observations at Catania show a more marked lowering, namely, from 8.5″ to 7.8″. The altitude is almost constant at all latitudes and it appears that the maximum was reached in 1926, this coinciding with the maximum activity of the protuberances. The total area of the latter, measured in units of protuberance, fell by 298 from 1926 to 1927 and by 53 from 1927 to 1928. Moreover, in 1928, the secondary maximum of the areas of high latitude had quite disappeared, the other maxima being distributed irregularly in both hemispheres. Curves expressing the height of the chromosphere, the area of the protuberances, and the relative number of spots from 1921 to 1928 indicate general concordance between the three magnitudes, except that the number of spots has continued to increase up to 1928.—**Maria Pastori**: The partial derivation of tensors.—**M. Picone**: Particular formula for the solutions of a classical fourth order equation of mathematical physics with partial derivatives.—**R. Caccioppoli**: Indefinite integration.—**A. M. Bedarida**: The theory of ideals of a finite algebraic body.—**B. Segre**: Existence and dimensions of continuous systems of plane algebraic curves with given characters.—**M. Lelli**: A new experimental result on the contraction of liquid veins. An experimental arrangement is described by means of which it is possible, as was anticipated by Levi-Cività's theory, to obtain an efflux of water with a coefficient of contraction less than one-half.—**E. Gugino**: The intrinsic equations of the motion of material systems with linkages independent of the time.—**O. Belluzzi**: The behaviour of elastic segmental arches.—**A. Belluigi**: Fundamental physical characteristics of the Paduan plain.—**P. Dore**: The influence of the elasticity of the support on the duration of oscillation of two pendulums oscillating on it.—**M. Tenani**: Theoretical experimental considerations on the course of the tides of the Adriatic Sea.—**E. Fermi**: The quantistic theory of interference fringes. On the basis of Dirac's theory of radiation, a theory is evolved of Lippmann's fringes. The method adopted is applicable generally to the treatment of any interference phenomenon, and the result arrived at coincides with that of the classical electromagnetic theory.—**W. Del Regno**: The total emissive power of bismuth.—**R. Fedele**: A comparison between the variations with the magnetic field of the Hall coefficient, the thermo-electric power, and the resistance in ordinary and compressed bismuth. Experiments with bismuth indicate that, even if the magnetic field causes structural modifications in the metal, these have no influence on the variation of the Hall effect, the thermo-electric power, and the resistance. It must, therefore, be concluded that such variations are due exclusively to purely electrodynamic actions, and that the failure of the electronic theories to explain these phenomena is to be numbered among the negative proofs of the theories.—**S. Oberto**: A supposed effect of X-rays in crystal rectifiers. The results of experiments with the Cuprox rectifier, commonly used for charging small accumulators, indicate that sparks establish a more intimate contact between the external electrode and the cuprous oxide of this rectifier, and between the point and the crystal in galena rectifiers. Hence, Jackson's experiments on the effects of ultra-violet and X-rays on the characteristics of crystal rectifiers do not fully prove, in so far as X-rays are concerned, the supposed effect of these rays.—**E. Perucca**: The sensitiveness of electrometers. A conceptual difference in behaviour between quadrant, leaf, and wire electrometers used for the measurement of very small differences of potential by the heterostatic method is pointed out.—**V. Cagliotti and L. Malossi**: Double sulphates of bismuth and alkali metals (2). Double sulphates of bismuth and ammonium. Addition to concentrated bismuth nitrate solution acidified with nitric acid, of ammonium sulphate in amounts required for the 1 · 1- and 1 · 3-compound gives at 25° the latter, namely, $(NH_4)_3Bi(SO_4)_3$, in both cases. This double salt is in equilibrium with solutions containing between 25.5 and 40.36 per cent of ammonium sulphate. The compound $NH_4Bi(SO_4)_2$ may be obtained in the anhydrous form by crystallisation from solutions of bismuth nitrate and ammonium sulphate, although Luddecke prepared it in the octahydrated state.—**G. Charrier**: Polycondensed heteronuclear systems. When applied to 2-N-phenyl-1 . 2-naphtho-1 · 2 : 3-triazolequinone, Bally's synthesis of benzanthrone from anthraquinone, which was extended to phenanthraquinone by Turski and Prabierowa, yields a compound which appears to be the 2-N-phenyltriazole analogue of benzanthrone.—**A. Bianchi**: Petrographical observations in the region of the Aurine Alps and Giant Vedrettes.—**S. Ranzi**: Experimental embryological investigations on the cyclostomes: (1) the malformations observed and the time in which they may be determined. Experiments on the ova of *Petromyzon planeri Bl.* show that, in non-fatal doses, lithium chloride never results in irreversible modification of an organ which is developing at the moment the salt acts, but may only determine modifications of processes which begin some time after the action of the salt commences.—**G. Reverberi**: Results of experiments on the development of the eye in hen's embryos.—**C. Guareschi**: Otocysts of *Anura* considered as a mosaic system. Experimental demonstration.—**R. Margaria**: The reaction-regulating power of sea-water. In view of the interest attaching to sea-water as a physiological liquid, its titration curves with dilute solutions

alkali and strong acid have been studied. In the acid zone and in the first part of the alkaline zone, sea-water exerts but little resistance to displacement of its reaction, but from $pH$ 10-11 onwards, a relatively high addition of sodium hydroxide produces but little change in the hydrogen ion concentration. The latter effect is, however, not a true buffering, but is due to the precipitation of magnesium hydroxide. At $pH$ 7·4, the buffering power of sea-water is only 0·0016, whereas that of blood serum is 0·0206.—**A. Galamini**: Partial inanition of albino rats with olive oil, administered with or without added vitamins.—**G. Finzi**: Anæsotuberculin in the diagnosis of tuberculosis in comparative pathology.

## Official Publications Received.

### BRITISH

Royal Society of Arts. Cantor Lectures on The Treatment of Coal, delivered before the Royal Society of Arts on Jan. 21st, 28th, and Feb. 4th, 1929, by Dr. C. H. Lander. Pp. 40. (London.) 2s. 6d.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda No. 1249 (Ae. 400): Measurement of Lateral Derivatives on the Whirling Arm. By L. W. Bryant and Dr. A. S. Halliday. (T. 2757.) Pp. 6+10 plates. 6d. net. No. 1253 (M. 64): Report on some Properties of Alloys of Aluminium with Thorium and Silicon. By J. G. Grogan and T. H. Schofield. (A. 63.) Pp. 12+11 plates. 1s. 6d. net. No. 1257 (Ae. 406): Comparison of Calculated and Measured Elasticity of the Wings of an Aircraft, in connection with the Investigation of Wing Flutter. By K. T. Spencer and D. Seed. (Ft. 41.) Pp. 9+2 plates. 9d. net. No. 1261 (Ae. 410): Experiments on the Spinning of a Bristol Fighter Aeroplane. By K. V. Wright. (T. 2703.) Pp. 7+2 plates. 6d. net. No. 1244 (M. 63): The Influence of Oxygen on Corrosion Fatigue. By A. M. Binnie. (E.F. 213A.) Pp. 3+5 plates. 6d. net. No. 1258 (Ae. 407): Notes on the Flutter of Airscrew Blades. By E. Lynam. (Ft. 40.) Pp. 4+6 plates. 6d. net. No. 1263 (Ae. 412): Full Scale Determination of the Motion of an Avro Aeroplane when Stalled. By K. W. Clark and W. G. Jennings. (T. 2790.) Pp. 6+5 plates. 9d. net. No. 1262 (Ae. 411): The Application of the Servo Principle to Aileron Operation. By A. S. Hartshorn. (T. 2792.) Pp. 16+5 plates. 9d. net. (London: H.M. Stationery Office.)

Ordnance Survey. Results of the Magnetic Observations made by the Ordnance Survey in England in 1927, and Preliminary Results (Declination only) of those made in England and Wales in 1928. Pp. 7. (London: H.M. Stationery Office.) 1s. 3d. net.

County Council of the West Riding of Yorkshire. Twenty-fifth Annual Report of the Education Committee, 1928-29. Pp. 99. Handbook of the Education Committee. Part 2: Higher Education. Section 9: Regulations relating to Training of Teachers, 1930. Pp. ii+14. Section 10: Regulations relating to Scholarships and Exhibitions, 1930. Pp. iii+54. (Wakefield.)

Transactions of the Royal Society of Edinburgh. Vol. 56, Part 2, No. 16: On Abnormal Teeth in certain Mammals, especially in the Rabbit. By Prof. W. C. M'Intosh. Pp. 333-407. 9s. 6d. Vol. 56, Part 2, No. 17: The Metamorphic Rocks of Kintyre. By William J. McCallien. Pp. 409-436. 8s. 6d. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

### FOREIGN.

Department of the Interior: Bureau of Education. Bulletin, 1929, No. 13: Land Grant Colleges and Universities, Year ended June 30, 1928. By Walter J. Greenleaf. Pp. v+81. 15 cents. Bulletin, 1929, No. 25: Trends in Home-Economics Education, 1926-1928. By Emeline S. Whitcomb. Pp. 22. 5 cents. (Washington, D.C.: Government Printing Office.)

Proceedings of the United States National Museum. Vol. 76, Art. 5: Three New Land Shells of the Genus Oreohelix from Arizona. By William B. Marshall. (No. 2802.) Pp. 3+1 plate. (Washington, D.C.: Government Printing Office.)

Bernice P. Bishop Museum. Bulletin 65: Report of the Director for 1928. By Herbert E. Gregory. Pp. 58+8 plates. (Honolulu.)

Japanese Journal of Botany: Transactions and Abstracts. Vol. 4, No. 4. Pp. v+317-426+81-110. (Tokyo: National Research Council of Japan.)

Division of Fish and Game of California. Fish Bulletin No. 17: Sacramento-San Joaquin Salmon (*Oncorhynchus tschawytscha*) Fishery of California. By G. H. Clark. Pp. 73. (Terminal, Calif.: California State Fisheries Laboratory.)

The Rockefeller Foundation. Annual Report, 1928. Pp. xi+460. (New York City.)

Bulletin of the Earthquake Research Institute, Tokyo Imperial University. Vol. 7, Part 2, September. Pp. 193-388+plates 10-30. (Tokyo.)

Memoirs of the College of Science, Kyoto Imperial University. Series A, Vol. 12, No. 5, September. Pp. 227-274. (Tokyo and Kyoto: Maruzen Co., Ltd.) 1.80 yen.

The Science Reports of the Tohoku Imperial University, Sendai, Japan. Fourth Series (Biology), Vol. 4, No. 3. Pp. 473-576+plates 19-25. (Tokyo and Sendai: Maruzen Co., Ltd.)

Instituts scientifiques de Buitenzorg: "'s Lands Plantentuin". Treubia: recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 7, Suppl., Livraison 3, Septembre. Pp. 101-147. (Buitenzorg: Archipel Drukkerij.) 2.50 f.

Bulletin of the National Research Council. No. 72: Fellowships and Scholarships for Advanced Work in Science and Technology. Compiled by Callie Hull and Clarence J. West. Second edition. Pp. 154. (Washington, D.C.: National Academy of Sciences.) 1.50 dollars.

### CATALOGUES.

The Cambridge Bulletin. No. 64, November. Pp. 24+8 plates. (Cambridge: At the University Press.)

Medicinal Glucose (Pure Dextrose) B.D.H. Pp. 7. (London: The British Drug Houses, Ltd.)

A Christmas Catalogue of Book Bargains. (No. 336.) Pp. 32. (Cambridge: W. Heffer and Sons, Ltd.)

"Carola" Photo Electric Cells and Vacuum Relays. (List C. 1029.) Pp. 8. (London: Isenthal and Co., Ltd.)

## Diary of Societies.

### FRIDAY, NOVEMBER 29.

INSTITUTE OF CHEMISTRY (Belfast and District Section) (at Queen's University, Belfast), at 7.—R. L. Collett: The Professional Aspects of a Career in Chemistry.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—R. H. Parsons and others: Debate on The Registration of Reliable Tests of Power Plant Machinery.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—W. C. Freeman: Modern Welding Systems and Applications.

LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemistry Section) (jointly with Leicester Association of Engineers) (at College of Technology, Leicester), at 7.30.—Dr. J. N. Friend: Science in Antiquity.

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Graduates' Section) (at 51 West Regent Street, Glasgow), at 8.—J. W. Robertson: Two-stroke Engines: Some Experiments on a New Type.

### SATURDAY, NOVEMBER 30.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students Section) (Newcastle-upon-Tyne), at 3.—F. Y. Pattern: A Few Notes on Miners' Nystagmus.—Paper open for further discussion:—Machine Mining in Faulted Ground, by A. L. Ford.

ROYAL SOCIETY, at 4.—Anniversary Meeting.

ROYAL IRISH ACADEMY (Dublin).

### MONDAY, DECEMBER 2.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Sir Ambrose Fleming: The Garden Tomb at Jerusalem: A Possible Site of the Resurrection.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. V. G. Childe: The Early Colonisation of Northern Scotland as illustrated by the Recent Discoveries in Orkney.

SOCIETY OF ENGINEERS (at Geological Society), at 6.—C. S. Chettoe: Some Points in Reinforced Concrete Bridge Design.

BRITISH PSYCHOLOGICAL SOCIETY (Education Section) (Annual General Meeting) (at London Day Training College), at 6.—Miss Lucy Fildes: Child Guidance Clinics.

INSTITUTION OF AUTOMOBILE ENGINEERS (Western Centre) (at Merchant Venturers' Technical College, Bristol), at 7.—Dr. B. P. Haigh: The Relative Safety of Mild and High Tensile Steel under Alternating and Pulsating Stresses.

INSTITUTION OF AUTOMOBILE ENGINEERS (Loughborough Graduates' Branch) (at Loughborough College), at 7.—H. G. Nicoll: Carburettors and Carburation.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—R. A. Chattock: The Modern Use of Pulverised Fuel in Power Stations.

ROYAL SOCIETY OF ARTS, at 8.—Dr. E. G. Richardson: Wind Instruments from Musical and Scientific Aspects (Cantor Lectures) (III.).

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—O. M. Tweedy: The Central African Highway.

### TUESDAY, DECEMBER 3.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.

LONDON NATURAL HISTORY SOCIETY (Annual General Meeting) (at Winchester House, E.C.), at 6.30.—W. E. Glegg: The Birds of Middlesex since 1866 (Presidential Address).

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (Informal Meeting) (at North British Station Hotel, Edinburgh), at 7.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—F. Judge: The Possibilities of Night Photography.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Graduates' Branch) (at Broadgate Cafe, Coventry), at 7.15.—P. Wheeler: Commercial Vehicle Engines.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—M. A. Phillips: British Wild Life.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—J. B. Hoblyn: Aluminium Alloys from the User's Point of View.

TELEVISION SOCIETY (at Engineers' Club), at 8.—E. G. Lewin: Television: Some Suggested Schemes.

ROYAL EMPIRE SOCIETY, at 8.30.—Sir Richard Gregory: Science and the Empire.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—A. L. Armstrong: Report of Excavations in the Cave of Bambata and at the Victoria Falls, South Rhodesia, 1929.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 8.30.—W. H. Ogilvie, H. Platt, J. Verrall, and others: Discussion on Minor Injuries about the Elbow Joint.

### WEDNESDAY, DECEMBER 4.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. E. Greenly: Foliation in its Relation to Folding in the Mona Complex at Rhoscolyn (Anglesey).—H. P. Lewis: The Avonian Succession in the South of the Isle of Man.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—G Shearing and Capt J W S Dorling Naval Wireless Telegraphy Communications

INSTITUTE OF METALS (Swansea Local Section) (at Thomas Café, Swansea), at 7 —G Croft Coke Carbonisation and Bye Products

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at 29 Hart Street, W C 1), at 7 —R C Cluing Costing Methods for Heating Engineers

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Graduate Section) (at Bolbec Hall, Newcastle upon Tyne), at 7 15 —R Munton Pulverised Fuel Past and Future

INSTITUTION OF AUTOMOBILE ENGINEERS (at Metropole Hotel, Leeds), at 7 30 —A Healey The Pneumatic Tire in Heavy Transport

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8 —Prof A P Laurie The Methods of Examining Pictures (Lecture) —R L Andrew The Determination of Minute Amounts of Iodine in Soils and Waters —Dr S Glasstone and J C Speakman The Quantitative Analysis of Mixtures of Nickel and Cobalt

ROYAL SOCIETY OF ARTS, at 8 —H H Peach The Advertiser and the Disfigurement of Town and Countryside Criticisms and Suggestions

ENTOMOLOGICAL SOCIETY OF LONDON, at 8

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8 30 —Pathological Evening

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub Centre) (at Derby Technical College) —Lt Col H E O'Brien Electric Traction

ROYAL MICROSCOPICAL SOCIETY (Biological Section)

*THURSDAY*, DECEMBER 5.

ROYAL SOCIETY, at 4 30 —F L Arnot Electron Scattering in Mercury Vapour —F A B Ward, C E Wynn Williams, and H M Cave The Rate of Emission of Alpha Particles from Radium —Dr E J Williams and F R Terroux Investigation of the Passage of Fast Beta Particles through Gases —*To be read in title only* —E P Perman and W D Urry The Compressibility of Aqueous Solutions —R J C Howland On the Stresses in the Neighbourhood of a Circular Hole in a Strip under Tension —G S Adair The Thermodynamic Analysis of the Observed Osmotic Pressures of Protein Salts in Solutions of Finite Concentration —E B R Prideaux and F O Howitt The Electrophoresis of Protein Sols in the Presence of Gold Sols—Albumen Gelatin and Casein —S. Bhagavantam The Magnetic and Optical Properties of the Benzene Ring in Aromatic Compounds —E C Watson and J A. Van den Akker Differences in the Directions of Ejection of X Ray Photo Electrons from Various Atomic Levels —Prof C R Goldsbrough and D. C Colborne The Tides in Oceans on a Rotating Globe III —A M Mosharrafa Wave Mechanics and the Dual Aspect of Matter and Radiation —Dr H T Flint On the Determination of the Range of Frequencies within the Group of Mechanical Waves of an Electron —Dr H Spencer Jones The Light of the Night Sky Analysis of Intensity Variations Observed at the Cape, at Canberra, and in England

LINNEAN SOCIETY OF LONDON, at 5 —Miss E S Grubb The Biological Station of Alto da Serra, Sao Paulo, Brazil —Continuation of the Discussion of the Proposed Introduction of Black Buck into Ceylon

PHILOLOGICAL SOCIETY (at University College), at 5 30 —Sir Israel Gollancz Problems in the Alliterative Poems

CHILD STUDY SOCIETY (at Royal Sanitary Institute), at 6 —Dr C W Saleeby Sunlight and the Child

INSTITUTION OF ELECTRICAL ENGINEERS, at 6 —Dr H Norinder Surges and Over Voltage Phenomena on Transmission Lines due to Lightning and Switching Disturbances

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6 30—J. de la Cierva Recent Work on the Autogiro

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Chamber of Commerce, Birmingham), at 6 30 —H M Stanley Petroleum and Petroleum Gases in Chemical Raw Materials

CHEMICAL SOCIETY, at 8 —U. R Evans and J Stockdale Passivity of Metals Part III The Quantity and Distribution of the Superficial Oxide —H Baines The Argentothiosulphuric Acids and their Derivatives Part I The Preparation of the Sodium Salts and the Isolation of Monoargentomonothiosulphuric Acid.—Prof W N Haworth and C R Porter (*a*) Sugar Carbonates Part IV The Dicarbonates of Glucose, Fructose, Mannose, Galactose, and Arabinose, (*b*) Isolation of Crystalline *α* and *β* ethylglucofuranosides (*γ* ethylglucosides) and other Crystalline Derivatives of Glucofuranose

C B C SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Essex Hall, Strand), at 8 —Debate on Birth Control M I Finucane, opposing, Dr Marie Stopes, defending

*FRIDAY*, DECEMBER 6

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—J P Davidson The Manufacture of Tobacco

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Newcastle upon Tyne), at 6 —Prof Dempster Smith Cutting Capabilities of Lathe Tools

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with Manchester Section of Institution of Rubber Industry) (at Engineers' Club, Manchester), at 7.—H C Young The Common Factors of Technical and Works Controls in the Rubber and Chemical Industries

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7 —Dr C. V. Drysdale Alternating Current Potentiometers and their Applications

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7 —W A Tookey and others Diesel Engine Developments

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7 —H Bairstow and others. Discussion on How can the Pictorial Group best help the would be Pictorialist?

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7 30 —A B Gowring: The Demolition of Lambeth Bridge

GEOLOGISTS' ASSOCIATION (at University College), at 7 30.—The Great Barrier Reefs and the Queensland Coast a Geographical Reconnaissance (Lecture)

ROYAL INSTITUTION OF GREAT BRITAIN, at 9 —Hugh Walpole: The Novel and the Creative Spirit.

*SATURDAY*, DECEMBER 7

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Western District) (at Exeter), at 3 —Lieut Col E J Stead The Local Government Act, 1929

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W C 1), at 3 —W H Spreadbury Some Birds of London's Country

MINING INSTITUTE OF SCOTLAND (at Glasgow)

## PUBLIC LECTURES.

*FRIDAY*, NOVEMBER 29

COLLEGE OF MEDICINE (Newcastle upon Tyne), at 8 —Prof A E Boycott The Causes of Cancer (Chadwick Lecture)

*SATURDAY*, NOVEMBER 30

HORNIMAN MUSEUM (Forest Hill), at 3 30 —H N Milligan The Hydra in Fact and Fiction

*MONDAY*, DECEMBER 2

ROYAL COLLEGE OF SURGEONS, at 4 —F W Twort The Relation of Pathogenic to Saprophytic Micro organisms (Succeeding Lectures on Dec 4, 6, 9, and 11)

LONDON SCHOOL OF ECONOMICS, at 4 30 —E H Warmington The Debt of Mediæval Explorers to Ancient Discoverers (3) The Exploration of Eastern Waters to China Unknown Southern Continents

*TUESDAY*, DECEMBER 3

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7 —Prof A W Ashby Changes in Prices of Farm Produce and their Causes

UNIVERSITY OF LEEDS, at 8 —Prof J W McLeod Immunity

INNER TEMPLE HALL, at 8 15 —Dr W A Robson Public Health Law and Administration introduced by the Local Government Act, 1929 (Chadwick Lecture)

*WEDNESDAY*, DECEMBER 4

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4 —Dr A C Jordan Dress in Relation to Health and Disease

*THURSDAY*, DECEMBER 5

ROYAL SOCIETY OF MEDICINE, at 5 —Prof H P Mosher: The Lower End of the Esophagus at Birth and in the Adult (Semon Lecture)

*SATURDAY*, DECEMBER 7

MATHEMATICAL ASSOCIATION (London Branch) (at Bedford College for Women), at 3 —Prof H Levy. Dimensional Theory as a School Subject (Presidential Address)

HORNIMAN MUSEUM (Forest Hill), at 3 30 —M A Phillips British Wild Life off the Beaten Tracks

## EXHIBITION, ETC.

DECEMBER 4, 5, AND 6

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RONTGEN SOCIETY (at Central Hall, Westminster)

*Wednesday, Dec* 4, at 2 30 —Official opening of Exhibition by The Rt. Hon. Arthur Greenwood

At 3 15 —Prof Gosta Forssell Radiotherapy of Malignant Tumours in Sweden (Mackenzie Davidson Memorial Lecture)

At 8 45 (at 32 Welbeck Street) —Dr G B Batten and others Discussion on The Requirements of Clinicians from Radiologists and *vice versa*

*Thursday, Dec* 5, 10 30 A M to 12 30 P M —Discussion on Aspects of Radiation Therapy

At 2.30 —Prof F. L Hopwood and Miss F E Smallman. The Use and Abuse of Radium Needles

At 6 —Prof A S Eddington X rays in the Stars (Silvanus Thompson Memorial Lecture)

*Friday, Dec* 6, 10 30 A M to 12 30 P M —W E Schall A Single Valve Plant for Diagnosis and Deep Therapy —Cuthbert Andrews A Mobile X ray Unit —Dr Ffrangcon Roberts. Modern Radiological Developments in Germany with Special Reference to the New Institute at Frankfurt —Dr A Orlhansky Output of Transformers under Different Methods of High Tension Rectification —W. R Gray A Hot Cathode Tube with Rotating Anode —Dr E J H. Roth The Mekapion, an Ionisation Apparatus for the Absolute Measurement of X ray Dose.

At 2 30 —Miss S F Cox and F G Spear Tissue Culture and its Application to Radiological Problems —Miss S F Cox The Action of X rays on Living Cells Cultivated *in vitro* —Dr F G Spear The Immediate and Delayed Effects of Radium on Tissues Cultivated *in vitro*

## CONFERENCE.

DECEMBER 5 AND 6.

INSTITUTION OF CHEMICAL ENGINEERS (at Chemical Society) —Vapour Absorption and Adsorption

*Thursday, Dec.* 5, at 10 30 A M —Prof J C Philip: The Reversibility of the Adsorption Process and the Thickness of the Adsorption Layer.—Dr W. R Ormandy The Recovery of Acetone Vapours from the Air

At 2.30 —H Hollings, Dr. S Pexton, and Dr R. Chaplin: The Recovery of Benzol from Coal Gas, with Special Reference to the Use of Activated Carbon —H. W. Webb The Absorption of Nitrous Gases

*Friday, Dec* 6, at 10 30 A.M —A. Hoch. The Recovery of Volatile Solvents (Bregeat Process) —J S. Morgan The Continuous Fractionation of Gases by Adsorbents

At 2.30 —G. W Himus: Evaporation of Water in Open Pans [illegible] Evans and H F Pearson. The Industrial Application of Active [illegible]

SATURDAY, DECEMBER 7, 1929.

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*Editorial and Publishing Offices.*

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## The Nation and Research.[1]

THERE is no need to dot the i's and cross the t's of the remarkable pronouncement on scientific research delivered by Sir Walter Fletcher and quoted extensively in NATURE of Nov 23. It may be said to have contained nothing new. it may, with equal justice, be said that its whole burden and content was new In it, a great public official who is also a man of science illuminated every facet of a problem which intimately concerns the future of human life. The revealing beam was not uniformly intense, and wisely so. Aspects exist of which it may be said that a pale and gentle light upon them suffices for the time being

Candle-power will be needed later, and then there will come into play the same dispassionate scrutiny as science accords to all those appearances which more partial judgments stigmatise ill-proportioned The time will come What is new in the masterly treatment which the Norman Lockyer lecturer gave to an urgent topic is the promise it affords that the time will come swiftly. It is not that the intellectual resources of England, nay, of the world, should be reorganised. It is that they are even now being recast by minds of whose effective potency the world has been abundantly assured. What Sir Walter Fletcher demands, and the best scientific opinion is with him, is something perfectly clear and consistent. What he calls the " national habit of thought about science " is not, of course, strictly national It is a world habit which that taste for mixing the true with the untrue, the wise with the unwise, the noble with the ignoble, the effectual with the ineffectual, that taste for mixing and muddling (which Englishmen prize themselves for priding themselves upon) only accentuates in us. He has attacked this habit trenchantly With what we must believe to be considerable courage, he has dared even to define the dangers to which the very fruitfulness of science exposes it.

" The State ", said Burke, " is a partnership in all science, a partnership in all art, a partnership in every virtue and in all perfection ", and so too Sir Walter Fletcher, " that Government will always be wise that makes the Universities strong and leaves them free "

Here lies the crux of the problem of intellectual reconstruction in England. Here all plans must have their origin, all aims their inspiration, and all discussion its starting-point and its end. Is it

[1] Medical Research: the Tree and the Fruit By Sir Walter Morley Fletcher. (The Norman Lockyer Lecture, 1929) Pp 27. (London. The British Science Guild, 1929) 1s.

possible to frame such a constitution for the universities of Great Britain, and after Great Britain the world, as will make them strong with the strength not only of great States, but also with the strength of the irresistible power of the human mind, sceptreless, free, uncircumscribed?

The question is born of the times, set before us as an aim of practical politics by one who is at the heart of the problem, secretary to one of those committees of the Privy Council in closest touch with each side of the triangle: the "bitter need of suffering men and women", the "national habit", and the devices of a profession. Of these three, the needs of men are constant, the "national habit", also, is all too constant; only for one profession we may write another and again another until the whole field of science will be comprised. The problem is defined, and with equal clearness, the essentials of reform. Equity demands that "if usefulness is to be measured by prominence and influence in the State" it shall be served accordingly; and usefulness rests upon a condition: that science "be left free to follow the clues to new knowledge as Nature lays them down and not as administrative officers may appoint". The administrative officer has, of course, disguises which it is unnecessary to pierce for the moment.

Here are plain indications of the essentials of future policy, resolving into administration and finance of the universities. No university is, of course, wholly scientific. But if science should be the means of elevating the condition of the rest, the result may be no worse than a displacement of the baser legends of scholarly gentility. Where there is great science, there also is high culture. Every claim to national respect for science is a claim equally for all sincere and disinterested thought.

The expenditure of the universities of England is less than four millions a year. (The cost of the lunatics of England has been eight.) To assess the value of the universities would be impossible. They are creators of values. To allocate to them what they need and can use would be to subtract from the present and the yearly wealth of the country a minute and unnoticable portion. In the old days such a portion was subtracted from the value of crops and given to the Church. The Church was left free under a Board of Commissioners and a Bench of Bishops to manage its affairs, to study and to teach, to accept the gifts of the laity in stones and carving, in money and in kind. At All that is best in a new fact, a new idea, or a new ideal synthesis, all that is best in science is from the moment of its birth the property of all; and despite the fact that in science doctrine does not exist to confuse and disintegrate, it is the Church and not science that is to-day the superior in status, in emoluments, and in freedom from the dictation of the vain and the ignorant.

Here are, we believe, the materials for reconstruction ready at hand, with every indication that historical experience can afford for correction and improvement. A State department, no. In "The Apple Cart" of Mr. Bernard Shaw, it is King Magnus, not a Minister, who speaks of protecting science from prostitution to the professions. Science is the concern of the State; it must not be the tool of the State even if in that guise its lot would be better than now when it is the hobby of philanthropy and the tool of commerce.

The present position is as absurd as it is intolerable. Private generosity provides scarcely more than a tenth of the income of the universities. Yet it retains effective control. It is for this reason that the "national habit" is even more firmly entrenched within the universities than in the Press and the street, the promises of charters and statutes, insufficient as these are, out of measure imposing in comparison with the meagre performances of the laboratories. Teaching, at the university level, is impossible without research, and probably, though less certainly, research is improved by contact with common needs. But it is not essential that changes immediately apparent in the form or even the personnel of governing bodies are necessary. Small changes of the right kind may go far: it is the sources and the character of the inspiration of policy that stand in need of change. Finance and stability are the clear lines for improvement. For the correction of the "national habit" itself, a people trained in a single science, not alone in the facts and uses of that science, but also in its discipline and method, will at least have received the means of entering fully into the spirit of all science.

We foresee strenuous opposition to the course on which Sir Walter Fletcher has set us, and at the same time we find it hard to envisage a vast army of support. But there is weight of support. The universities, except the greatest of them, are frightened and demoralised, the cross currents of interest baffling. But we reassert our conviction that the address is the beginning of a new era in the life of the country. It sets an urgent practical problem for solution.

## Enzymes.

*Untersuchungen uber Enzyme.* Von Richard Willstatter. Band 1 Pp. xvi + 860. Band 2. Pp xi + 861-1775 (Berlin Julius Springer, 1928) 124 gold marks

IN these two volumes, which are dedicated to Dr. Fritz Haber, there are reprinted the collective memoirs on the subject of enzymes from the school of one of Germany's greatest chemists The collection comprises more than a hundred and thirty original contributions to the subject, the first eight of which are summaries of our knowledge. The vast number of co-workers whose names are given suggests team work, but if this be so, the greatest homage must be paid to the master mind that directed it.

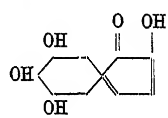
Prof Willstatter and his school have attacked a chemico-biological problem from the point of view of the pure chemist. Prof Willstatter may, in fact, be compared with the late Prof Emil Fischer. His researches, like those of Fischer, have been directed towards unravelling the constitution and structure of naturally occurring substances, and his achievements have not been in vain, for they have shown the physiologist and the biochemist the nature of a series of basal units of substances met with in Nature, and have thus laid the foundation on which attempts may be made to elucidate their physiological function and metabolism in the more complex colloidal state in which they occur in the animal and plant.

It is quite unnecessary to summarise at any length the advancement of our knowledge due to Willstatter's researches: this is well known and was described by Prof. H. E. Armstrong when Willstätter was added to NATURE's series of "Scientific Worthies" in the issue of July 2, 1927. But in leading up to a short review of his work on enzymes, it will be useful to give a brief historical outline of his earlier work in the sequence in which he has drawn it up in the introductory chapter of this series of papers The work on chlorophyll having been brought to a provisional conclusion, Willstatter commenced the study of hæmoglobin; in this the remarkable discovery was made that it is possible to obtain from both chlorophyll and hæmoglobin a common derivative, ætioporphyrin. Studies on the colouring matters of petals were then commenced, and these were shown to be the oxonium salts of three closely related substances, pelargonidin, cyanidin, and delphinidin. These studies were, however, brought to a close by the outbreak of the War.

Willstatter's work on enzymes really commenced with the discovery in 1910 of chlorophyllase, an enzyme present in all green leaves. Experiments *in vitro* showed that in alcoholic solution it hydrolyses colloidal chlorophylls into ethyl chlorophyllides and the complicated $\alpha$-$\beta$ unsaturated primary alcohol, phytol. The majority of the work on enzymes, however, has been published since the close of the War

The two volumes are divided into ten sections, the first of which comprises eight papers of the nature of summaries. In this first section the opening paper is the Faraday lecture delivered before the Chemical Society in London in 1927. The other sections are concerned with original researches on the following subjects: Analytical work, adsorption, chlorophyllase, peroxidase and catalase, sucrase, maltase, lactase, the specificity of enzymes, the lipases and the proteases

Although, as already stated, Willstatter's work on enzymes commenced in 1910 with the discovery of chlorophyllase, his general study of the subject dates from 1918 Before the various problems could be attacked it was necessary to devise special analytical methods, and a series of papers was published dealing with these He greatly increased the accuracy of the iodometric method of estimating glucose as well as that of the colorimetric estimation of iron by means of ammonium thiocyanate. Alkalimetric methods of estimating amino acids and peptides, as well as of magnesium and calcium, were also revised. The want was felt of an accurate micro-method of estimating phosphoric acid, and gravimetric and volumetric methods were devised for this purpose in Willstatter's laboratory by R. Kuhn. It was shown that the production of purpurogallin by the action of plant peroxidases and hydrogen peroxide on pyrogallol might be used for the estimation of the enzyme. Incidentally, Willstatter proved that the constitution of purpurogallin is




whilst he accepts A. G. Perkin's view that the constitution of the isomeric purpurogallon is 6 : 7 : 8 trihydroxy $\alpha$ naphthoic acid.

Truly remarkable is Willstätter's work on the different hydrogels of alumina, stannic acids, and silica, and the use to which he put these as adsorbents in the purification of enzyme preparations. According to Michaelis, enzymes exhibit the

phenomenon of kataphoresis and are therefore to be regarded as electrolytes, in most cases amphoteric Enzymes that are adsorbed by electro negative kaolin were regarded as more basic, whilst those adsorbed by electro-positive alumina were regarded as more acidic. Thus sucrase was believed to be acidic and trypsin amphoteric. The Willstatter school finds, however, that these results are not valid for the enzymes themselves but only for associated foreign impurities For example, sucrase in the crude state is not adsorbed by electro-negative kaolin, whilst in a state of greater purity it is readily adsorbed by kaolin. Pancreatic amylase can be adsorbed by alumina when in a crude state, but it is no longer adsorbed by special alumina gels when in a state of greater purity.

The specificity of enzymes is well marked in several instances. The observations of R Kuhn are of particular interest in this connexion He points out that the sucrase of yeast which hydrolyses sucrose and raffinose is a fructo-sucrase, because it attaches itself to the fructose residues in sucrose and raffinose. The sucrase of *Aspergillus oryzæ*, on the other hand, is a gluco-sucrase because it attaches itself to the glucose residue in sucrose: it does not hydrolyse raffinose Fructose added to a sucrose solution undergoing hydrolysis by sucrase of yeast slackens the velocity of hydrolysis. Glucose, on the other hand, slackens the velocity of the hydrolysis of sucrose by Aspergillus-sucrase.

Willstatter, whilst admitting that W. Ostwald's dictum that catalysis is the acceleration by a foreign substance of a reaction which is already proceeding slowly in absence of that substance, gave a stimulus to research on enzymes, insists that it should not be maintained too dogmatically, since as a dogma it would tend to hinder any attempt to find an explanation of the phenomena of catalysis without intermediate compounds and of the causation of reactions without an influx of energy. Ostwald's conception is easy to understand in the case of hydrolysis of sucrose, maltose, and the fats, and even in certain oxidative changes, but it is difficult to realise in that of some of the desmolases, for example, that of alcoholic fermentation, even when we picture this as a change of oxido-reduction.

When it is considered that these laborious researches are the outcome of but ten years' work, no one can fail to be struck with admiration at the accomplishment of such a feat. Nor is the work the less remarkable when it is examined in detail. The methods of attack that have been devised are of the most ingenious character and have not only achieved their object and carried our knowledge several stages forward, but they have also added indirectly much to the chemistry of the colloidal state of matter

Highly meritorious as this work undoubtedly is, it still leaves us in doubt regarding the chemical nature of enzymes. Of the true nature of enzymes as substances we know but little We can only assume their individuality by a knowledge of the reactions which occur in their presence. Their function is to catalyse reactions, and in this respect analogies may be found in the early work of Faraday, Mitscherlich, Berzelius, and others on the catalysis of reactions in inorganic chemistry.

It would seem that in all catalytic reactions the first stage is the combination of the catalyst with the substrate, possibly through the medium of residual affinities This view is by no means a recent one It was supported by Fischer and by the work of H. E and E. F. Armstrong. So far as enzymes are concerned, some idea of the way in which this combination may occur is furnished by the suggestion of Northrop, that, in the case of proteoclastic enzymes, the velocity of the reaction depends not on the dissociation of the enzyme, as postulated by the hypothesis of Michaelis, but on that of the substrate. Thus pepsin, the optimum activity of which is shown in a strongly acid medium, is capable of reacting only with the protein kations and trypsin with the protein anions. Willstatter suggests the existence of a third group of enzymes capable of attacking only undissociated protein molecules, their optimum hydrogen ion concentration corresponding with the iso-electric point of the substrate.

In regard to reactions catalysed by enzymes the question may be asked: Are the final products the result of direct or of secondary changes? The former is that which has long been assumed, whilst much evidence is being accumulated in favour of the latter. Thus the work of Pringsheim on the hydrolysis of starch by amylase indicates that some of the maltose is produced by the mutation of another disaccharide, and more definite evidence has recently been brought forward by Pictet that this disaccharide is one of the $\gamma$ class. In my own laboratory, work is in progress which confirms this both in the case of starch and of glycogen. Willstatter had not overlooked this possibility. He says:

"The catalyst may function in degrees of association with the substrate, varying from *fixation* to *approach*. It can naturally without extraneous energy bring about a change of constitution in the substrate molecule, and it is only through the

constitutional change that reaction may be induced Here it is not essential, nor even a general condition, that the molecule should change to a new compound capable of independent existence, as, for example, to an isomeride such as the so-called γ-glucose (with a changed oxygen bridge) which has been postulated as an intermediate in the action of F G Banting and E H Best's insulin on glucose F Haber (1922) considered the heterogeneous catalysis of gas reactions to be a process in which the first phase is apparently represented by an electro-dynamic distortion of the molecules by the atomic fields at the interface between the solid contact substance and the gas M Bodenstein also bases an explanation of the activation of hydrogen by platinum on the deformation of the molecules "

Again, considering the chemical nature of enzymes as substance, are they to be regarded as single substances, or are they not rather a system? There is much to be said in favour of the latter view Despite repeated attempts—none more numerous than those carried out by the Willstatter school—no one has succeeded in preparing a single pure substance from enzyme preparations, possessing activity which characterises these agents as a class The most highly purified preparations —judging purity by the increased velocity of the reactions they catalyse—have always been mixtures Moreover, purification by adsorption always stops at a certain point. The classical researches of Harden showed that zymase, or rather yeast juice, may be resolved by ultra-filtration into an inactive thermo-labile colloidal portion and an inactive thermo-stable portion which passes through the filter The active enzyme is reproduced when these two portions are reunited The case of trypsinogen may also be cited. This only becomes active trypsin when brought in contact with the enterokynase of the duodenum, which may owe its activating power to the presence of calcium ions. Willstatter in 1922, summarising his views on the nature of enzymes, states that he considers them to be composed of a specific active group which enables them to be combined with the substrate, the composition of which at the same time determines the colloidal nature of the entire complex.

It would seem that researches on enzymes have now been carried to a conclusion so far as is possible with methods at present at disposal. We must patiently await the devising of new means of attack before the problems can be carried to a further stage. Meanwhile universal gratitude must be expressed to Prof. Willstätter and his co-workers for having taught us so much on one of the most intricate problems in the whole range of biochemistry.

ARTHUR R. LING.

## Memorials of Galileo.

*Memorials of Galileo Galilei, 1564–1642: Portraits and Paintings, Medals and Medallions, Busts and Statues, Monuments and Mural Inscriptions.* By J J Fahie Pp xxiv+172+47 plates (Leamington and London: The Courier Press, 1929) 30*s*.

FEW figures have so struck the imagination of the world as the aged and infirm Galileo. Repressed by the power of the Inquisition, humbled into submission by the temporal power which crushed those deeper stirrings of the human spirit that were leading men to new conceptions of the universe and of man's place therein, "My name is erased from the book of the living", he wrote to his loved daughter Yet through well-nigh four centuries the roll of his disciples has not closed.

Not least in devotion has been the author of the finely produced volume now before us Mr Fahie's engineering knowledge and long experience in Italy have given him an intimate appreciation of much of Galileo's achievement. Yet more fundamental to his work have been the affection and veneration which Galileo has inspired in him. Mr Fahie has devoted years to the study of his master, and he became the chief collaborator of the late Prof. Favaro in the preparation of the great national edition of the works of Galileo published by the Italian Government. English readers are already indebted to Mr. Fahie for his volume, "Galileo, his Life and Work", published as far back as 1903, and for his study of "The Scientific Works of Galileo" in 1921. Probably no other man now living is equipped with the knowledge which makes these "Memorials" a volume full of charm and interest as well as an authoritative reference book on its subject.

Every authentic portrait of Galileo finds a place in this volume. The sources of prints as well as of paintings have been traced, and errors and false ascriptions have been hunted down and exposed. Moreover, a lifelong study has been rewarded by more than one important new discovery. The ground is covered with great completeness. The work is divided into six parts: Portraits from life; subject pictures; medals and medallions; busts and statues; monuments and mural inscriptions; and finally, an entertaining appendix on spurious Galileos.

The work is prefaced by a graceful and illuminating character sketch. In few words there is placed before us what we may call the domestic background of the great philosopher, his fondness for gardening, his familiarity with masterpieces of

classical literation, his generosity, his hospitality, and his love of music. Very touching was the devotion of his pupils, especially of the youngest, Vincenzio Viviani, who as a lad of eighteen came to live with the master in 1639, six years after the historic sentence had been promulgated in Rome A relationship of warm affection was almost immediately established between Galileo and this lad, who became in his turn a leader of the science of the next generation To Viviani, too, we owe much of our knowledge of the brilliant circle of young men who in the first decade of the seventeenth century formed in Rome the Academy of the Lynx This was by far the earliest society for the study of natural science, and very early in its career was honoured by the adherence of Galileo.

One of the discoveries of Mr Fahie is in connexion with a bust of Galileo by Caccini, which was to have been executed as a gift from Salviati for Prince Cesi, the founder and the first president of the Academy of the Lynx. Owing to the death of Caccini, the marble bust was never made, but Mr Fahie has traced the original plaster model by Caccini himself which now reposes in the Master's Lodge at Trinity College, Cambridge!

Among the things that will strike the reader of Mr. Fahie's beautiful volume is the great number of contemporary portraits. One of the most remarkable and least familiar is that produced from a crayon drawing by Leoni, dated 1624, now preserved in the Louvre. The immense and thought-laden head is here lightened by an expression of benignity in the eyes not always discerned by the artists who set themselves to delineate that countenance. Mr. Fahie reproduces no fewer than four portraits from the hand of Sustermans, but this famous artist did not work on Galileo until after the tragedy of 1633. Three of the paintings were made in 1640. One, and as he believes the original, has been discovered by Mr Fahie in London in the private possession of Miss V. F Robinson

Yet more numerous than the portraits are the later memorials of Galileo. His condemnation by the Inquisition has been the subject of many fine pictures. Many painters have found inspiration in his life in confinement, his thoughts ever occupied by the movements of the heavenly bodies and by the laws of his 'new science' of mechanics Always he was surrounded by the pupils who venerated him More than one painter has been stirred to depict the visit of the young John Milton to that venerable figure. Gradually Galileo has become a legend. His name and his achievements have come to hold a special place in the minds of those for whom freedom of thought and speech is a precious human heritage, won with how much suffering and how easily lost!

Medals have been struck and monuments raised in Galileo's honour In Florence he is commemorated by the Tribuna di Galileo, a department of the Museum of Physics and Natural History. This Tribuna was opened in 1841 and consists of a vestibule, a small hall, and a semicircular inner tribuna The walls are decorated with frescoes illustrating the achievements of Galileo, while the cases contain instruments with which he won his knowledge. Perhaps no material monument of him is more touching than the bust with inscriptions and representations of his discoveries which Viviani, greatly daring, placed on the front of his own house in the year 1693. Below, a legend for all to see linked the owner of the house with the man whom the Inquisition had condemned *Monumenti consecrati da Vincenzio Viviani alla memoria del Galileo.*

DOROTHEA WALEY SINGER

## Sex in Savagery.

*The Sexual Life of Savages in North-Western Melanesia. an Ethnographic Account of Courtship, Marriage and Family Life among the Natives of the Trobriand Islands, British New Guinea* By Prof Bronislaw Malinowski Pp xxiv+506 +96 plates (London · George Routledge and Sons, Ltd., 1929) 42s net.

ALREADY the admirable volume under review has created an interest far wider than its primary appeal to professed anthropologists would indicate, and it may confidently be claimed for it an established place as a sociological classic, which in future no serious student of culture in its broadest terms will be able to pass by.

So slight, and for the most part unmethodical and unscientific, have been all previous studies of the sexual life of primitive peoples in the English language, that Prof. Malinowski's becomes the first really important work in this line of research. In previous volumes he had led up to this more detailed and embracing study by discussing special problems in psychology and sociology, for example, the Freudian incursion into cultural anthropology, and, in other volumes, primitive law, economics, myth, religion, and folk-lore. Other workers approaching these subjects from outside have too often muddied the stream of knowledge and theory by speculations and reconstructions not based on observable facts.

In this volume we are given a very full and

detailed picture of the erotic and family life of Trobriand Islanders It is, of course, apparent that what is typical of Trobriand tribesmen is not necessarily typical of primitive communities, or even of all Melanesians Here we are studying a mother-right and matrilineal community in which a man inherits from his maternal uncle, in which the real father's part in procreation is shown to be as unknown as the late Sir Baldwin Spencer showed it was unknown amongst the Arunta of Australia, in which, subject to certain exogamic and kinship taboos, prenuptial and even prepuberal sexual intercourse is almost unrestrained In every instance where he is dealing with the beliefs and practices of the natives, the author's peculiarly intimate knowledge of the language, his own psychological penetration and his familiarity with a mass of comparative material, enabled him, not merely to state custom and belief in native terms, but also to demonstrate how logically they do arrive at those beliefs For example, the native refusal to believe that sexual intercourse is necessary to procreation is applied to their theories on the breeding of pigs. The male function is merely to 'open up' by hymeneal penetration and prepare the channel of ingress for the spirits, which are the real fertilising agents In defence of this belief, the natives point to the free sexual life of unmarried girls and the comparative absence of illegitimate children. Since, they argue, all women, married or unmarried, have either husbands or lovers, but only some have children, the father's part cannot be essential.

In this connexion we touch on a problem of some biological importance, the solution of which lies, as Prof. Malinowski avers, outside the scope of his work. It is one, however, which I have had under consideration as the result of observations made amongst other Pacific peoples. Where, as in the Trobriands, prenuptial intrigues are the rule, illegitimate births are none the less discountenanced, and, by all the evidence, in any case, remarkably rare. The common and easy explanation that unmarried mothers practise abortion, or that some unanalysed and mysterious form of contraception is practised, is quite unsupported by any evidence in the communities in question. This latter popular explanation is particularly inappropriate in the Trobriands, where the fertilising function of seminal fluid is unknown. Yet girls habitually begin an active sexual life from the time they are still quite small children, and, until they marry, remain sterile. After they marry they breed and are often prolific. In the Trobriands, if, as rarely happens, an unmarried girl becomes pregnant, her lover, so far from then being more inclined to marry her, would on the contrary at once repudiate her; not, of course, because of any suspicion of a rival's responsibility, but simply because it is a violation of custom and even more discreditable for an unmarried girl to have a child than for a married woman to remain sterile. The only explanation that I am inclined to put forward touches the postulated law that monandrous matings only are favourable to fertility The mechanism of it may, it is suggested, be discovered to lie in the autotoxitous properties of spermatozoic saturation The experiments still being carried on in California and elsewhere in spermatoxins and sterilising serums, associated with work begun by Dittner, Guyer, and others, may eventually reveal the true physiological or biochemical explanation Meanwhile, a study of tertiary sex-ratio variations will illustrate the world-wide tendency for the substitution of monandrous and polygynous groups for polyandrous groups in a population. This substitution occurred quite clearly, for example, in the Toda population in recent years. We may see here its bearings upon the institution of marriage and polygamy. This question is one amongst many showing the need for a closer collaboration between sociological, demographic, and biological researches.

Here and there the author has to touch on the gradual changes brought about by the influence of contact with European civilisation. Often this influence is exercised deliberately and directly by government officials and missionaries determined to reform and 'uplift' the morals of the debased savage. In almost every instance that influence has been harmful and has resulted in the weakening or destruction of the morality that once existed. The segregation of sexes on plantation compounds and mission stations has lead to homo-sexual practices previously practically unknown; violation of the taboo on incest is now brazened out, where exposure would formerly have led to suicide; missionary attacks on native polygamy and the institution of the boys' houses, *bukumatula*, have merely helped to make adulteries more easily accomplished without punishment, have undermined the power of the chiefs, and disintegrated society. A new cynicism and hypocrisy is the chief lesson the white man's religion teaches.

Mr. Havelock Ellis, in his preface, makes an eloquent plea for a full and scientific consideration of the underlying sexual facts in all sociological inquiries, free alike from the traditions of Anglo-Saxon Puritanism and the almost equally

unfortunate reactions to which the revolt against those traditions may lead After a study of Prof. Malinowski's work, we may indeed be inclined to think Mr. Ellis's statement that "Sex-taboos weigh at least as much on the civilised as on the savage mind" an under-statement

GEORGE PITT-RIVERS

## Our Bookshelf.

*West African Secret Societies: their Organisations, Officials and Teaching* By Capt F W Butt-Thompson. Pp 320+12 plates (London: H. F. and G. Witherby, 1929) 21s net.

THE West African secret societies, according to Capt. F. W. Butt-Thompson, fall into three groups the mystic and religious, the democratic and patriotic, and the subversive and criminal; some are ancient pagan institutions, others are Mohammedan, there is a group of Mohammedan-pagan societies, and there are more modern ones The various aspects and activities of the societies, such as organisation, officials, initiation, religious teaching, etc, are given in appropriate chapters with reference to particular societies; thus the reader can appreciate what factors are common to most of them, and so is enabled to gain a bird's-eye view, as it were, of their general functioning. Finally, there is a very brief account of each society

This is the first systematic book on the subject, and the author is to be commended for the considerable amount of information here summarised. Judging from the bibliography, he has searched diligently through the literature which has any bearing on his subject, and he appears to have got into friendly contact with many Africans in the different countries of which he treats, especially in Sierra Leone, but unfortunately there is no indication concerning what is due to original observation and what is taken from published sources, so there is no means of gauging the reliability of the statements here made.

It is a book that tells in brief many things about which we should like to know more, and though Capt. Butt-Thompson records such information as may be obtained by a white man concerning the old social discipline and morality, there must be much more of which probably only an African can enlighten us. As in many primitive communities, some of the ethical teaching, such as that given on pp. 208-9, is good enough for any people to practise, however advanced their scale of life; for example, "Respect and obey your father and mother". "Be just to your enemy; rescue him when he is in danger, and never go out of your way to get him into trouble." "Stealing is undignified; if you covet a thing, ask for it; if it is refused, go without it." A people that preaches these maxims cannot lightly be dismissed as 'heathen', nor can their secret societies always be branded as 'wicked'. The author makes us wish that we could get into real and close touch with the teachers of these doctrines, and work out with them a better and a fuller way of combining their knowledge and aspirations with our own for the benefit and advance of the African

A. C. H

*The Private Life of Tutankhamen: Love, Religion and Politics at the Court of an Egyptian King* By G. R Tabouis Translated by M R Dobie Pp. xxiii+322+16 plates (London George Routledge and Sons, Ltd, 1929) 15s net

To attempt to recreate the atmosphere and reconstruct the conditions of a whole period of history so remote from our own times as the XVIIIth dynasty of ancient Egypt, requires considerable courage. It is a task to which the genius of the French language is perhaps more readily adaptable than our own Certainly in one or two places this translation of Mlle Tabouis' book on Tutankhamen carries less conviction than it would in the original On the whole, however, it is a sound and informative piece of work such as should appeal strongly to the general public. The period with which she deals is one of the relatively few epochs in Egyptian history possessing an individuality and a character comprehensible by a reader who is not already acquainted with the phases of development of Egyptian culture in some detail.

An account of Akhenaton and his religious and social reforms necessarily occupies a prominent place in the book, which is thus given a certain dramatic unity, so much so that, instead of a life of Tutankhamen, it might well be regarded as the story of the rise and decay of the materialised ideal of a political and religious dreamer. M. Theodore Reinach contributes a preface, which is illuminating in the way it sets out in a few paragraphs the distinctive characteristics of Egyptian political development, which play so large a part in the history of Akhenaton's reforms, and also in giving the historical perspective necessary to appreciate the place of the XVIIIth Dynasty in Egyptian history.

*The Life of Space.* By Maurice Maeterlinck Translated by Bernard Miall. Pp. 171. (London: George Allen and Unwin, Ltd., 1928.) 6s net.

SINCE the publication of work on the theory of relativity during the War made this subject one of popular interest, there have been many attempts to interpret the significance of the theory in its relation to everyday life. The problem of the fourth dimension is one which occasionally is transformed from the symbolical language of mathematics to the imaginative fancy of popular writing. It is therefore with added interest that one turns to a book of this description by Maurice Maeterlinck. The work is divided into five sections, but the first one, namely, that of "The Fourth Dimension", is the longest and gives various references to writers who, like Hinton and Ouspensky, have devoted considerable thought to the implications of the fourth dimension. Maeterlinck then deals with "The Cultivation of

Dreams " and makes particular reference to dreams as premonitory phenomena. The following section is headed "The Isolation of Man" and raises the question of whether the mind may acquire the sense of the fourth dimension, thus being liberated from our present human environment The book concludes with two short articles on "Marvels of Space and Time" and "God" The subject dealt with is, of course, a very wide one and lends itself to much speculation, and among the great number of names to which reference is made we find those of Eddington and Whitehead.

*Old Mother Earth.* By Prof. Kirtley F Mather. Pp xiv + 177 + 59 plates. (Cambridge, Mass.: Harvard University Press, London: Oxford University Press, 1928) 11s 6d. net.

IN view of conditions in Tennessee, where scientific evidence and spiritual exposition continue to be confused with unfortunate public results, it is not surprising that popular American books on geology are still seriously exercised with the views held in ancient Palestine thousands of years ago Prof Mather has faced the issue very tactfully in this entertaining volume, which is based on a series of radio talks delivered at Boston The topics dealt with include the origin of the earth; the evolution of life; the Great Ice Age and its causes; earthquakes and mountain building All are adequately dealt with, and we are glad to see that the tidal theory of Jeans and Jeffreys is not overlooked in the discussion of "How the World was Made". The treatment of glaciation is excellent, particular pains being taken to prove that the equator had the same relation to the mountains of western America as it has to-day. The illustrations are numerous and effective, and are enlivened by reproductions of medieval representations of Jehovah at work taken from the "Nuremberg Chronicle" of 1493. The book is a well-written and trustworthy introduction to geology, and may be cordially recommended to all who are interested in the lore of the earth as students or teachers.

*The Pressure Pulses in the Cardiovascular System* By Prof. Carl J. Wiggers (Monographs on Physiology.) Pp. xi + 200. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1928.) 14s. net.

WRITTEN in response to the wish of the late Prof. Starling that the writer should analyse "in the briefest possible manner, the present state of our knowledge concerning the pressure pulses in the cardiovascular system", it is impossible to indicate in a paragraph more than the purpose of this book, and to commend the thoroughness and care with which the work has been done. The elucidation of the dynamics of some relatively simple physical system frequently entails much preparation and ingenuity in experiment The first chapter of this work will indicate to the curious how vast and intricate a preparation has gone to the study of the dynamics of the animal cardiovascular system. There has developed a technique which not more than ten investigators have mastered. "We cannot deny that the circulation of an animal is affected adversely by such experimental influences as artificial respiration, anæsthesia, hæmorrhage, nerve stimulation, exposure of heart and lungs, insertion and fixation of cannulæ We can nevertheless maintain that it is quite possible to obtain circulatory conditions which appear to be normal to all criteria which we are able to apply." Such an assertion argues a great confidence in an investigator, a confidence which, if justified, marks a great victory for ingenuity over the difficulties of animal experiment.

*Contributi del Laboratorio di Statistica.* Serie Prima. (*Pubblicazioni della Università Cattolica del Sacro Cuore, Serie ottava · Statistica*, vol 3) Pp vii + 436 (Milano Società Editrice "Vita e Pensiero", 1928) 50 lire.

THIS book contains the researches of statisticians of the laboratory directed by Prof. M. Boldrino, on a varied group of phenomena, for example: the eugenic effect of wine consumption, passenger traffic on Lake Maggiore, the proportion of the sexes at conception and birth, death from a single cause, progressive paralysis in malaria districts. Among such a miscellaneous group of subjects one can find a certain unity due to the method of treatment and to the work being the product of a single laboratory. Some of the conclusions drawn from the statistics employed are very interesting

(1) That alcoholic intoxication appears to have serious consequences only at a rather advanced age, so that its eugenic effect should be small.

(2) That the human sexes are conceived in equal numbers

(3) That the relative frequency of progressive paralysis in malaria districts is high and tends to become less in those districts where malaria is less rife. This is curious in view of the successful treatment of progressive paralysis by inoculated malaria.

*Sunrays and Health.* By Ronald Millar, in collaboration with Dr. E. E Free Pp vii + 125. (New York: Robert M. M'Bride and Co., 1929.) 1.50 dollars

THIS small volume gives a popular account of the physics and therapeutic uses of light, with special reference to the ultra-violet rays. The text is in a conversational and simple style, and although certain details refer more especially to the continent of America, it can be recommended for perusal by anyone who wishes to have some knowledge of the uses and abuses of a much-advertised remedy. The author gives simple instructions for sun-bathing and points out the dangers of over-exposure: burning the skin is deleterious and unnecessary as a prelude to a becoming tan He also points out the advantage of exposure to sunlight or skyshine in the open air with the accompanying effect of the cooling power of the air on the skin resulting in stimulation of metabolism and benefit to health. For those who wish to expose their skin to ultra-violet rays during the winter, directions for time of exposure and distance from the lamp are given. In conclusion, this is a sane and readable account of a natural remedy which many are inclined to take in excessive doses.

## Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications*]

### Low Atomic Energy Levels for Elements of the Oxygen Group.

From spectral theory it is known that the lowest energy states for atoms of the oxygen group form a stable triad designated as $^3P_{012}$. Next higher to these is a metastable state $^1D_2$ and next to that again a metastable state $^1S_0$. For oxygen atoms the state $^3P_1$ expressed in frequency units is known to be 67 cm.$^{-1}$ higher than the state $^3P_2$ and the state $^3P_0$ 158 cm $^{-1}$ higher than the state $^3P_1$. The states $^1D_2$ and $^1S_0$ have not hitherto been evaluated for oxygen atoms

In the course of a recent investigation of the spectra of selenium and tellurium, we were able to identify all the energy levels $^3P_{012}$, $^1D_2$ and $^1S_0$ for the neutral atoms of both elements. The results are given in the following table:

| | | | | | | |
|---|---|---|---|---|---|---|
| | $^3P_2$ | $^3P_1$ | $^3P_0$ | $^3P$ mean | $^1D_2$ (suggested) | $^1S_0$ (suggested) |
| Oxygen . | 0 | 67 | 225 | 97 | 10587 | 28512 |
| | Energy differences | | | | 10490 | 17925 λ5577 341 A |
| | $^3P_2$ | $^3P_1$ | $^3P_0$ | $^3P$ mean | $^1D_2$ (suggested) | $^1S_0$ (suggested) |
| Sulphur . | 0 | 398 | 572 | 323 | 9523 | 25723 |
| | Energy differences | | | | 9200 | 16200 λ6300 A. |
| | $^3P_2$ | $^3P_1$ | $^3P_0$ | $^3P$ mean | $^1D_2$ | $^1S_0$ |
| Selenium . | 0 | 1991 | 2535 | 1509 | 9576 | 23370 |
| | Energy differences | | | | 8067 | 13794 λ7247 5 A |
| | $^3P_2$ | $^3P_0$ | $^3P_1$ | $^3P$ mean | $^1D_2$ | $^1S_0$ |
| Tellurium . | 0 | 4707 | 4751 | 3153 | 10559 | 23199 |
| | Energy differences | | | | 7406 | 12640 λ7909 2 A. |

For tellurium it will be seen the terms $^3P_{012}$ are partially inverted, $^3P_1$ being higher than $^3P_0$ Mean values for the energy levels $^3P_{012}$ are 1509 cm.$^{-1}$ for selenium and 3153 cm $^{-1}$ for tellurium. If we consider the ratio $(^1D_2 - {}^3P_{\text{mean}})/(^1S_0 - {}^1D_2)$ we obtain the value 0 585 in the case of selenium and 0 586 in the case of tellurium.

From observations made on the Zeeman effect with the oxygen green line λ5577·341 A and described by Prof. McLennan in his Bakerian Lecture (Nature, July 7, 1928, p. 38, and *Proc. Roy. Soc.*, No. A 785, vol. 120, p 327), it became definitely known that the auroral green line λ5577 A. originates in electronic transitions between the metastable states $^1S_0$ and $^1D_2$ of oxygen atoms. It has a frequency, therefore, given by $\nu = {}^1S_0 - {}^1D_2$ which, expressed numerically in frequency units, is equal to 17924 7 cm.$^{-1}$ If we suppose that the ratio $(^1D_2 - {}^3P_{\text{mean}})/(^1S_0 - {}^1D_2) = 0{\cdot}585$ be applicable to the spectrum of oxygen as well as to the spectra of selenium and tellurium, we obtain 10490 cm.$^{-1}$ and 28415 cm.$^{-1}$ for the mean energy difference $^1D_2 - {}^3P_{012}$ and $^1S_0 - {}^3P_{012}$ for oxygen atoms. From this it follows that the radiation corresponding to the electronic transitions $^1D_2 - {}^3P_{012}$ in oxygen should have a mean wave-length of approximately λ9530 A. and that corresponding to the transitions $^1S_0 - {}^3P_{012}$ an approximate wave-length of λ3520 A. This means that we should expect to obtain in the spectrum of the polar aurora and in that of the light of the night sky a close triplet in the neighbourhood of λ9530 A and a similar one in the neighbourhood of λ3520 A, the separations in both cases being 67 cm $^{-1}$ and 158 cm.$^{-1}$ Up to the present such radiations have not been observed either in polar or non polar auroral light or in the spectrum of atomic oxygen They should, however, be carefully looked for and experiments in that direction are now being set in train by one of us

From the numbers given in the table above it will be seen that the lines in the spectra of selenium and tellurium analogous to the auroral green line of oxygen have the wave-lengths λ7247 5 A. and λ7909 2 A. respectively Moreover, by extrapolation from the numbers given in the table, one is led to the view that a line in the spectrum of sulphur analogous to the auroral green line of oxygen should have an approximate frequency of 16200 cm.$^{-1}$ and an approximate wave length of λ6300 A.

J C. McLennan.
M F Crawford.

### The Grant of Invalid Patents.

The trend of the excellent leading article in Nature of Nov 9, on "The Grant of Invalid Patents", is to recommend that more power be entrusted to the Patent Office because of the great evil of expensive patent litigation, but in the course of the article two statements occur which I submit are misleading. The writer says (1) that opposition proceedings before the Comptroller are coming to be used as a cheap method of obtaining an official opinion of validity. Now I believe it to be beyond dispute that the Comptroller's decision has no importance whatever as a certificate of validity, and validity is not a question with which he is at all concerned at the hearing of the opposition proceedings. Definite grounds of opposition are laid down by sec 11 of the Act, and with them he is alone occupied

Prior publication and prior grant may be, and are commonly, an issue before him, but his decision on these points merely amounts to saying that he cannot find the applicant's invention expressly stated in other specified documents which are put before him, and his decision on the point has no weight whatever in a subsequent action in the High Court.

Secondly, the writer says that the *quale* of subject matter is already handled by the Patent Office. This is only true in the limiting sense that the Patent Office will not grant a patent for something which is *manifestly* not a manner of manufacture, for example, a system of indexing *or* a medical treatment, even though it was described as a "method of extracting lead from men". Yet with this limitation any experienced patent agent will say that it is nearly always possible to get an invention through the Patent Office.

Space does not permit me to enlarge generally on the other point of view, though on it there is much to be said There is the danger of allowing Patent Office officials, excellent and efficient as they are, to decide academically and without proper evidence on what are after all practical questions—I say without proper evidence, for a full-dress trial at the Patent Office would, except for the comparatively small court charges, be as expensive as a trial in the High Court. Again, Patent Office 'mistakes' would be serious, for they would mean that improper grants were made, or that grants were improperly refused. So far as the lawyer is concerned, it might well happen that although the excessive cost of patent actions was reduced there would, nevertheless, be a very much greater number of small patent actions!

Is it not true, however, that the real cause of the expenses of the big patent actions is not so much the law as the exceeding complexity of modern science and technical knowledge, coupled with the immense financial interests which to day exist in business?

CARROL ROMER

5 Crown Office Row, E.C 4,
Nov 11

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MUCH of the leading article in NATURE of Nov. 9 involves the assumption that the purpose of patents is to encourage inventions, or even inventors. There may have been a time when that was true, though it must be remembered that the grant of a monopoly was originally a bribe for the disclosure of an invention, not a reward for making it, but it belongs to the remote past It was a time when the same person could be inventor, workman, foreman, manager, and director, when organised research was unknown, and industry progressed unforeseeably by discontinuous mutations In the completely different economic and intellectual atmosphere of the modern world, the patent machine has ceased to work according to the intentions of its designers and cannot fulfil the purpose for which they designed it With our admirable English adaptability, the envy of all foreign observers, we have converted it to other purposes, not less vital to the community. Patents now serve to provide financiers with convenient weapons for their mutual warfare, and patent agents with a living[1] The British Science Guild wisely recognised the change when it constituted its Patents Committee mainly of those who regard an invention merely as the occasion for the issue of a legal document. Industrial scientists would be wise to recognise it too

For in these days of trade unionism and rationalisation, no tinkering with patent law can enable an isolated inventor to fight an industry. In particular, what is the good of deciding the issue of validity once for all in the Patent Office, when the closely related issue of infringement cannot possibly be decided until it arises ? The Patent Office may declare generally that the patent claims something validly, but that something can only be defined by particular instances. Attempts to deprive wealth of its influence in one direction only drive it to seek influence in another, and the search is never long ; as many have asked before, if there were really justice between rich and poor, what would be the use of being rich? Instead of claiming rights of which the evolution of society has deprived us for ever, let us make the most of those that it has newly conferred on us. When the foundations of the patent law were laid, no one could earn a salary by indulging his disinterested curiosity

NORMAN R. CAMPBELL.

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Watford, Herts.

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IN reply to Mr. Carrol Romer's letter: it certainly is true that the Comptroller cannot give a certificate of validity or tie the hands of a higher court. The leading article was not intended to convey that impression at all. But it is also a fact that the carefully reasoned decisions, commonly running into 5000 or 6000 words, which are nowadays a feature of opposition proceedings, help the parties to see exactly where they stand, and often enable them to come to terms. In the event of an appeal, time (and therefore expense) is saved in the appeal proceedings by the Comptroller's preliminary elucidation of the issues. Does Mr Romer seriously maintain that the grounds of opposition are irrelevant to validity?

Mr. Romer seems to hold the view that the Comptroller does not enforce amendments, or otherwise exert his powers, except in such extreme cases as that in which an invention has been wholly and specifically described in a prior publication. That view is directly contrary to the writer's experience There has been a strong tendency, especially in recent years, for the Comptroller's court to deal quite courageously in realities and not merely in words. Public appreciation of this policy seems to be indicated by the rapidly increasing use which is made of the Comptroller's jurisdiction.

As regards the cost of evidence: an economy would obviously be effected if such issues as documentary anticipation could be kept out of the High Court Even if matters calling for a good deal of evidence were to be brought within the Comptroller's jurisdiction, a favourable precedent would be found in opposition proceedings based on the plea of 'obtaining'.

In his last paragraph Mr Romer surely is right in attributing the increasing cost of patent litigation to the increasingly scientific and technical character of industry. It follows that the High Court is ceasing to be a suitable place for the trial of many of the issues which affect validity. A judge's time is too valuable to be properly taken up with those cramming-courses in chemistry, physics, and applied mechanics through which the expert witnesses have to coach him, and patent law forms such a small fraction of the whole body of law that a technical training is more appropriate than a purely legal training for men who have to decide questions of technical fact. It is true that if mistakes made in the granting or refusal of a patent were to be rendered irrevocable, grants would be improperly made or refused, and that would be a serious evil. But the existing state of things is an incomparably *more* serious evil The risk of minor injustices is preferable to the actuality of major abuses.

Dr. Campbell's statement that "the grant of a monopoly was originally a bribe for the disclosure of an invention" appears to require revision in view of the actual history of the matter The writer is inclined to agree, however, that if the minds of the British Science Guild Committee had not been biased by a practical knowledge of their subject, their report would probably have been characterised by a high degree of novelty, though it might have fallen short in point of subject-matter and utility.

After all, the battle is not always to the strong, even under existing conditions. If the patent system were to be 'tinkered up' with courage and foresight, the duration of High Court proceedings might be considerably shortened, and then the salaries to be gained by indulgence in disinterested curiosity might come to be levelled up to a more satisfactory general average than that at present available.

THE WRITER OF THE ARTICLE.

[1] The fees paid to a few leading counsel always attract attention, but the fees paid to patent agents are much larger in aggregate; their function, if patents had retained their original purpose, would have been equally parasitic.

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## The Permeability of Plant Cell Membrane to Sugar.

THIS communication deals with a glucose effect on the permeability of cell membranes to sugar molecules as studied by the intensity of respiration when leaves of *Artocarpus Integrifolia* were injected with varying concentrations of glucose solution. The investigation developed as a very interesting by-product of other investigations on respiration. Though the important

rôle of carbohydrates in the physiology of the living cell has been recognised for a very long time, our knowledge concerning the direct penetration of living cells by carbohydrate molecules is only recent Scarcely anything is known, however, about the effect of sugar on the permeability changes of cell membranes to diffusion of sugar molecules Curiously, the direct evidence for an effect of this kind of sugars on the permeability of cell membranes is obtained from an investigation which had primarily nothing to do with the problem.

The investigation was concerned primarily with the study of respiratory intensity when starved and unstarved leaves were injected with varying concentrations of glucose solutions. The curves obtained in that connexion could not all be explained on the basis of a simple relationship between concentration and respiratory intensity, for which an explanation had to be sought.

Observations of the rates of respiration were recorded on the control and the experimental leaves simultaneously. For purposes of analysis, from the curves thus obtained the per cent algebraical increase of respiration of the experimental leaves over the controls have been calculated and exploited.

The equations for the curves of the hourly march of these values work out in a very simple way in the majority of these curves. They can be expressed as simple logarithmic curves.

For comparing the relationship between the concentration of sugar solutions and the respiratory intensity, the *initial* values obtained by extrapolating these curves to zero time have been plotted against the corresponding concentrations.

The generalised curves thus obtained at different temperatures show an ascending and a descending phase. It is the ascending phase which forms the special feature of this communication. This phase shows the mathematical relationship $R = K . Ct^n$, where $R$ is the rate of respiration, $Ct$ the concentration, $K$ a constant, and $n$ an index which is greater than unity, that is, respiration increases relatively more as concentration increases. This is explained in terms of the relatively greater rate of diffusion of sugar molecules as concentration increases. The only way in which this can happen is through variations in the permeability of cell membranes to the diffusion of sugar molecules as the concentration of glucose solution increases, thus supplying direct evidence of the effect of glucose on the permeability of cell membranes

In the equation given above, $K$ represents the diffusibility factor for the diffusion of sugar, which would vary at different temperatures, and the index $n$ the factor for variations in the permeability of cell membranes as the concentration of the solution increases.

In view of these results, the effect of various carbohydrates on the permeability of cell membranes must be known before one can investigate their quantitative effects on various physiological processes of metabolism, such as respiration, etc.

R. S. INAMDAR.
K. V. VARADPANDE.
Benares Hindu University, India,
Oct. 20.

### A Lantern Slide Model of the Wave Electron.

LECTURERS on the more popular aspects of the wave-electron may be interested in a simple lantern slide model for demonstrating the waves which I have not seen previously described. Based directly on an explanation given by de Broglie in his "Recherches sur la Théorie des Quanta" (*Ann. de Physique*, 3, p. 22; 1925), it has the advantage not only of showing the waves to an audience, but also of giving perhaps some insight into their nature. The model consists merely of the diagram of lines shown in Fig 1, which can be pushed horizontally in the lantern behind a fixed vertical slit

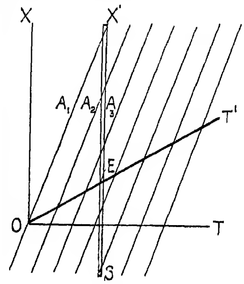


FIG. 1.

The figure represents the space time diagram of the observer of a moving electron. The observer is represented by the successive points of his time line $OT$, while of his space axes only $OX$ is drawn. The time line of the electron, in motion with respect to the observer parallel to $OX$, is $OT^1$ Now the electron has a known energy, $w = mc^2$, which on the electromagnetic theory is spread out in space round it, and also associated with the electron in some way (perhaps it is rotating with a fixed angular momentum), an elementary quantum of action, $h$, has to be admitted. From these known quantities we can deduce a certain time,

($8 \times 10^{-21}$ sec. for slow motion), and the diagram can be divided into cells, each containing the action $h$, by lines separated by intervals $\tau$ (measured along $OT$). These lines, representing instantaneous spaces associated with the electron, must be drawn perpendicular to $OT^1$. It is, however, a well-known feature of the pseudo-Euclidean geometry of space-time that a line which satisfies the analytical conditions of perpendicularity to $OT^1$ lies actually parallel to $OX^1$, where $\angle XOX^1 = \angle TOT^1$ when the velocity of light is taken as unity. The lines, $A_1$, $A_2$ . . ., separating the successive action cells, appear consequently as shown.

Now when the slide is covered by an opaque screen with a slit $S$ in it, and the diagram is moved behind it from right to left, we see the electron $E$ moving up the slit with the velocity $v$, while a train of phase waves, formed by those parts of the lines between the cells of action which show through the slit, passes up through the electron with a velocity $c^2/v$ in a very realistic way. Transparent lines on a dark background give the best effect.

S. R. MILNER.
The University,
Sheffield.

### The Subdivisions of the Order Primates.

IN his Croonian Lecture on "The Developmental History of the Primates", Prof. J. P. Hill referred to the late Dr. Hans Gadow's subdivision of the Primates into three sub-orders for reasons which I have previously explained in some detail (NATURE, May 2, 1907, vol. 76, p. 7, and *Proc. Zool. Soc. Lond.*, 1919, published Feb. 1920, p. 465).

My colleague has suggested that I should put on record the circumstances in which Dr. Gadow created the sub-order called by him 'Tarsii'.

In 1898, when Dr Gadow was preparing for the use of his students the book "A Classification of Vertebrata", the International Zoological Congress was held at Cambridge He undertook the task of translating and elaborating Haeckel's address to the Congress, which was afterwards published as a book under the title "The Last Link".

In the course of this task Dr Gadow was faced with the difficulty of bringing into harmony the views expressed at the Congress respectively by Haeckel and Hubrecht The former regarded the lemurs as ancestors of man and as Primates belonging to the same sub-order as *Tarsius*, whereas the latter wanted to exclude the lemurs altogether from the Primates and to regard the tarsier almost as an Anthropoid. Gadow invited me to Shelford to wrestle with this difficulty, and, after several days' discussion, he decided that there was only one way of effecting a reasonable compromise between the conflicting views While the lemurs could not be eliminated from the order, they should be separated from the tarsiers Hence he proposed a subdivision into three sub-orders, which he called respectively Lemures, Tarsii, and Simiae. Several years later (op cit *supra*) I brought these terms into closer relationship with traditional usage by calling the sub-orders Lemuroidea, Tarsioidea, and Anthropoidea My colleague, Prof J. P. Hill, has still further clarified the position by separating monkeys (which might be called Pithecoidea) from the apes and man (to which the term Anthropoidea might be restricted) as separate sub-orders—a proposal made by Friedenthal more than twenty years ago, the justification for which was graphically expressed in the phylogenetic diagram in my "Evolution of Man".

By emphasising the nearness of man's affinity to the anthropoid apes, this proposal gives expression to a conclusion which recent research in comparative anatomy, embryology, hæmatology, and immunology is making necessary. G. ELLIOT SMITH.

University College,
London, W.C.1,
Nov. 25

### Lankester's 'Gregarine' from the Eggs of *Thalassema neptuni.*

OUR attention has been directed by Mr. A D. Hobson, of the University of Edinburgh, to a sporozoan that attacks the developing eggs in the genital pouches (nephridial sacs) of the echiuroid worm *Thalassema neptuni* Gartner. Of twelve females examined at Plymouth this autumn, eight showed a heavy infection. It is clear that the parasite is the 'Gregarine' observed by Ray Lankester in the eggs of one mature female among those he collected on the south coast of Devon and briefly mentioned in a paper published in 1881 (*Zool. Anz*, Jahrg. 4, p. 250). Prof. and Mrs. Goodrich in their paper on *Gonospora minchinii* (*Quart. Jour. Microsc. Sc.*, vol. 65, p. 157; 1921) refer to Lankester's notes, but no one seems to have investigated further the organism from *Thalassema*.

A preliminary examination has shown us clearly that it is not a gregarine, but a coccidian; and as this is, so far as we know, the first recorded instance of such a parasite within an egg, we propose to work out the life-history in detail.

It is not surprising that Lankester supposed he was dealing with a gregarine, for the trophozoite is a long, worm-like body, 200 $\mu$ to 400 $\mu$ in length and 16 $\mu$ to 22 $\mu$ broad. The cytoplasm is densely granular and appears white by reflected light; the pellicle is very thin; the nucleus lies in the centre of the body. At this stage the parasite is coiled up within the egg; sometimes three occur together. When pressed out from its shelter, it shows no movement. The parasitised eggs degenerate and are liable to phagocytic invasion. We believe that we have found the schizogonic phase, in which 40 to 50 merozoites are formed, each measuring about 16 $\mu \times 12$ $\mu$. The gametocytes are spherical, the female larger than the male; occasionally a male and a female lie within the same egg. The males give rise to a very large number of flagellated microgametes We have not yet found the oocysts or spores, and so cannot at present say anything more precise as to the systematic position of the coccidian

The only true gregarine we have seen in *Thalassema* is a cephaline form living in the gut, sometimes in company with the ciliate *Ptyssostoma thalassemæ* Hentschel D L MACKINNON.
H. N. ROY.

King's College, Strand,
London, W.C 2,
Nov 21

### Influence of the Para-Foveal Regions on the Foveal Region of the Retina.

THE following simple experiment shows the above influence in a very conclusive manner Let a piece of black cardboard eight inches square be taken and place this on a wall paper with a coloured pattern. The light in the room should not be too bright, but the experiment can be done easily in an ordinary room with the daylight of the present time The black cardboard should be viewed with one eye at a distance of six feet, the eye being kept as immovable as possible. It will then be noticed that portions of the colours of the wall paper will appear to detach themselves from the wall paper and move with a slow spiral motion into the black area. This will go on until the whole black area has completely disappeared, the surface being covered with a mixture of colours similar to those on the wall paper.

If a Persian carpet be used for the purpose of the experiment the area will be covered with a mixture of the colours of the carpet. If a uniform colour be used the black area will be covered by that colour. It may even make another colour disappear. For example, if a piece of red paper an inch and a half square be placed on a piece of yellow-green cardboard the yellow-green will invade the red until only a yellow-green surface is seen. If any difficulty be experienced the reader should try the experiment in a dimmer light, but I have not found anyone, at present, who has not seen the phenomenon with ease. It will be noticed how strongly this phenomenon supports my theory of vision, which I regard as a fact, and it seems impossible to explain it on any other theory. F. W. EDRIDGE-GREEN.

Board of Trade,
S W, Nov. 19.

### Graptolite Centenary.

MY friend Dr. Ami is wrong in supposing that at the University of Birmingham I was associated with the work of Prof. Charles Lapworth on graptolites (NATURE, Nov. 16, p. 766). All that I can claim is to have set him free from some of the routine work of his professorship and thus helped him to find time to undertake more original investigation and writing than he otherwise could have done, including the editorship of the Monograph on the Graptolites, written by Miss Elles and Miss Wood (now Dame Shakespear). W. W. WATTS.

Langley Park Road,
Sutton, Surrey, Nov. 18.

# Recent Reactions between Theory and Experiment.[1]

## THE RAMAN EFFECT THE CONSTITUTION OF HYDROGEN GAS

By Sir ERNEST RUTHERFORD, O M , Pres R S.

IN watching the advance of science, and particularly of the physical sciences to day, one cannot fail to be struck by the very close connexion between theory and experiment—a relation which is probably more intimate than at any other period of scientific history Every new experimental observation is at once seized upon to test whether it can be explained by existing theories, and if not, to find the modifications necessary to include it in the general theoretical scheme of natural processes The mathematical analysis often suggests the possibility of unexpected relations which can be made the subject of fruitful experimentation These two, in a sense, complementary branches of physics profoundly react and interact with each other, and their united efforts lead to a greatly accelerated rate of advance in knowledge and understanding of the essential principles involved. The rapidity of advance in physics, which has been so marked a feature in the last decade, is mainly due to this close combination of theory with experiment

It will be seen that this interaction is clearly manifest in the subjects which I have selected to speak of to-day. I wish to refer briefly to certain recent discoveries which have excited much interest among physicists and chemists, and have thrown much new light on problems which have long been the subject of close investigation

The scattering of light by small particles and the 'Tyndall blue' of the scattered light, when white light from the carbon arc or the sun falls on a solution filled with a multitude of small particles, are well known. The late Lord Rayleigh in 1871 first gave the mathematical theory of the scattering of light by such particles, and was able to account in a general way not only for the colour of the reflected light but also for its state of polarisation. He suggested that light should be scattered, not only by particles containing many millions of molecules, but also by the individual molecules themselves, and that the blue of the sky was probably due mainly to the scattering of sunlight by the molecules of the atmosphere in its path.

This suggestion of molecular scattering was strikingly confirmed by the experiments of his son, the present Lord Rayleigh, who showed that scattering of light could be observed in gases freed from all dust nuclei, and that the light scattered perpendicularly to the direction of the incident beam was mainly plane polarised.

In recent years there have been a large number of investigations on the scattering of light, not only by gases but also by liquids and solids, with especial attention to the amount of scattered light and the degree of its polarisation. I shall not refer here to these results and the interesting deductions that have been made from them, but concentrate attention on a more recent development Sir Chandrasakara Raman, of the University of Calcutta, who had for many years experimented on this subject, made an important observation which has thrown much new light on this question. For simplicity, suppose that monochromatic light of a definite frequency passes through an organic liquid, say, benzene or toluene, which has been carefully purified It was observed that the colour of the scattered light was distinctly different from the incident beam, showing that the light had in some way been altered by scattering by the molecules in the liquid To examine this change more accurately, the scattered light was passed through a spectroscope A striking result was observed The strongest line was equal in frequency to the incident light, as was to be expected on the classical theory, but in addition a number of new lines were observed on the low-frequency side of the main line, and a few fainter ones on the high-frequency side. By the process of scattering, a set of new discrete frequencies had thus made their appearance An excellent account of these beautiful experiments was given this year by Raman and Krishnan in our *Proceedings* Similar effects were observed by Landsberg and Mandelstamm by examining the light scattered by certain crystals.

Such experiments are not easy, for the scattered light is very feeble, and long exposures with intense sources of light are necessary to bring out the relatively faint new lines. An examination of the results showed that the changes of frequency depend on characteristic frequencies of the molecule, connected with its vibrational states

The interpretation of these results is most clearly seen by consideration of the similar effects in gases, and we shall consider these first. For example, if $\nu$ be the frequency of the incident light, the frequencies of the new lines are $\nu - \nu_1$, or $\nu + \nu_1$, where $\nu_1$ is always found to be a difference between two fundamental frequencies of the molecule. This is completely in accord with the quantum theory of scattering, which was given formally by Kramers and Heisenberg in 1925 It is to be presumed that the light scattered by liquids is of the same nature, and the frequency shifts are due equally to differences of molecular frequencies; although in molecules, which absorb strongly in the infra-red, these differences may themselves appear as actual molecular frequencies.

It is of interest to note that the possibility of a process of this kind, involving the appearance of new frequencies, had been predicted by Smekal as well as by Kramers and Heisenberg. While theory and experiment agree admirably for gases, the theory could not have been legitimately extended to the case of molecules of a liquid, and here the Raman effect provides a new and effective tool for determining frequencies which are naturally present in a liquid or a solid.

[1] From the presidential address delivered at the anniversary meeting of the Royal Society on Nov 30.

It is clear that this new effect may be of great importance in determining the slow characteristic frequencies of molecules in the infra-red, which may be difficult to measure by other methods. This new discovery, of great interest in itself, thus promises to open up a new field of experimental inquiry and to throw valuable light on the modes of vibration and constitution of the chemical molecule.

It is naturally of great interest to consider the processes occurring in the molecule that give rise to these scattered radiations. The action of a train of waves in its passage through the complex electrical system of a molecule, which may be set in vibration in a variety of ways, is naturally very complicated and difficult to explain briefly in simple language. If, however, we content ourselves with a consideration of the energy changes only in the radiation, and disregard the detailed mechanism involved in the radiation processes, a simple explanation can be offered on the ideas of the light quantum.

We start by observing that it is a general consequence of wave mechanics that if a system possesses a number of states of equal energy, there is usually a finite probability of a transition from one of the number to any of the others. Consider a quantum of light, of frequency $\nu$ and energy $h\nu$, falling on a molecule in a given direction. The quantum and the molecule are to be regarded as a single system. This system has a number of other states of the same energy. First, those in which the molecule is unchanged and the original quantum is scattered in a new direction without change of frequency; transitions to these states correspond to Rayleigh scattering. Secondly, other states in which the state of the molecule is changed, its energy being altered by $\pm h\nu_1$, while a quantum of light of energy $h\nu \mp h\nu_1$ is scattered in some new direction. Changes to these states correspond to the Raman effect, where frequencies $\nu - \nu_1$ and $\nu + \nu_1$ are observed. The actual changes occurring in the molecule to give rise to these new frequencies can only be inferred from a detailed consideration of the possible modes of vibration of the molecule itself.

I shall now consider a very interesting discovery which has been made in the past year. It has been found that, in a sense, hydrogen consists of two different kinds of molecules, which under ordinary conditions of temperature and pressure behave in a distinctive way; for example, the specific heat and conductivity of the two kinds of hydrogen are very different. The hydrogen molecule in the normal state consists of two nuclei and two electrons. On the ordinary views of the gas-kinetic theory, it is to be expected that the molecules, in addition to their ordinary velocity of agitation, may rotate on an axis perpendicular to the line joining the nuclei. On the quantum theory, it has a series of states of rotation which are specified in terms of a quantum number which has the values 0, 1, 2, 3, etc. Experiments on the band spectrum indicate that in ordinary hydrogen gas at atmospheric temperature the molecules which have rotation numbers 1, 3, 5, are about three times as numerous as those with even rotation numbers, 0, 2, 4, . . For convenience, the molecules of even rotation number will be termed $\alpha$-hydrogen, and those with odd rotation numbers $\beta$-hydrogen.[2] When in equilibrium, the relative number of hydrogen molecules in the different rotation states at any temperature is governed by the well-known Boltzmann law of distribution and can be calculated approximately. If, however, ordinary hydrogen gas is reduced to a low temperature, say, that of liquid hydrogen, on the ordinary kinetic theory it is to be expected that the rotation of the molecules should practically vanish; that is, the majority of the molecules should have a rotation number 0 and only a small fraction, depending on the temperature, remain in the higher rotational states.

Actually, however, it is found that while $\alpha$-hydrogen is mainly in the rotation state 0, the $\beta$-hydrogen does not change into the state 0, at any rate for a long time, but retains its individuality, although, of course, the ratio of the number of molecules in each odd rotation state is governed by the Boltzmann law. The surprising fact emerges that the $\beta$-hydrogen under the influence of ordinary gas-kinetic collisions is only with great difficulty changed into $\alpha$-hydrogen. The time required for true equilibrium, after lowering the temperature, may be measured in months, or even in years under some conditions. This interval depends, as we should expect, on the pressure and temperature of the gas, since these govern the number and magnitude of the molecular collisions. This means that a molecule with odd rotation number finds a very great difficulty in passing to the even state of rotation.

A general explanation of this can be given on wave mechanics and appears to be intimely connected with the very weak coupling between a rotation state of the molecule with the spin of the minute individual nuclei (protons) which make up the molecule.

While under normal conditions, the passage of $\beta$-hydrogen into $\alpha$-hydrogen and vice versa is excessively slow compared with the duration of an ordinary experiment, yet the transitions can be greatly accelerated by appropriate treatment of the gas. For example, if hydrogen cooled to a low temperature is subjected to an electric discharge, there is a rapid transformation. The passage of the cooled gas through charcoal immersed in liquid air or liquid hydrogen acts in a similar way. When the hydrogen is rapidly cooled to the temperature of liquid air, the odd rotation states are much in excess over the equilibrium value. The passage through the charcoal causes a rapid transformation of the $\beta$-hydrogen and the emerging gas at the temperature of liquid air consists mainly of $\alpha$-hydrogen.

It is of great interest to note that if the gas is warmed to ordinary temperature after passage

[2] The terms 'para'- and 'ortho'-hydrogen have been sometimes used for what I have called $\alpha$ and $\beta$. This seems undesirable, since these names are still required to distinguish the *electronic* states in analogy with those of the helium spectrum.

through the charcoal, it remains mainly $\alpha$-hydrogen, while hydrogen gas in equilibrium consists only of about one-quarter of $\alpha$-hydrogen It has been found that the specific heat of the gas and its heat conductivity at the temperature of liquid air before passage through charcoal are markedly different from the values for the gas at the same temperature issuing from the charcoal. In a sense, we may say that $\alpha$-hydrogen has been obtained by this process in an approximately pure state The effect in charcoal cooled to the temperature of liquid helium would be even more complete. It seems probable that the rapid transformation brought about by passage through charcoal is catalytic in nature and may quite likely be due to the dissociation of the molecules into atoms and their subsequent recombination to form new molecules

This striking and unexpected behaviour of hydrogen—the simplest molecule known to us—is of great theoretical as well as experimental interest. It had been known for some time that no satisfactory theoretical explanation could be given of the change of specific heat of hydrogen with temperature, either on the kinetic theory or with the modifications of the theory based on the older form of the quantum theory.

A new orientation of our ideas was given by the development of the wave mechanics theory. One of the first triumphs of this theory was the explanation by Heisenberg of the complex spectrum of helium The two types of spectra which appeared were shown to be connected with the different directions of spin of the electrons themselves. In one case, the orbital wave functions were symmetrical and in the other case antisymmetrical. From analogy with the behaviour of the helium atom, Hund showed that it was to be expected that the hydrogen molecules should consist of two kinds, in one, which we have called $\alpha$-hydrogen, the wave functions were symmetrical in the rotational wave function and in the other, called $\beta$-hydrogen, antisymmetrical. It was recognised that, on the wave theory, there must be a very weak coupling between the symmetrical and antisymmetrical states, so that the transition from one state to the other must be fairly slow.

Dennison, in a paper published in our *Proceedings* in 1927, calculated the specific heat of hydrogen at different temperatures on the bold assumption that the time of transition from one state to the other was very slow—of the order of one year—compared with the time required for a determination of the specific heat experimentally. Under these conditions, ordinary hydrogen could be considered to be a mixture of two gases, which have not only different specific heats but a different variation with temperature.

By assuming that the ratio of $\alpha$- to $\beta$-hydrogen was 1 to 3, he found that the calculated and observed specific heats agreed over the whole range of temperature This ratio between the two states of hydrogen was in accord with the observations of T Hori on the band spectrum of hydrogen.

Experimental proof of the accuracy of this deduction was soon forthcoming by a variety of experimental methods. Prof J. C McLennan examined the Raman effect in liquid hydrogen and found that the changes of frequency observed in the spectrum of the scattered light indicated that hydrogen at this temperature consisted of a mixture of molecules having even and odd rotational states. The relative intensity of the lines was in accord with the relative distribution assumed by Dennison

About the same time experiments were undertaken by Eucken and Hiller and by Bonhoffer and Harteck in Berlin. Eucken and Hiller determined the specific heat of hydrogen under different conditions. Hydrogen at high pressure was kept for some days at the temperature of liquid air, the specific heat was measured at intervals and at different temperatures, and was found to show marked variations with time. The fraction of $\alpha$-hydrogen was found to vary from 25 per cent at the beginning to 95 per cent after a long interval It was found that the rate of transition from $\beta$- to $\alpha$-hydrogen at liquid air temperature depended on the pressure of the gas and was approximately proportional to the number of molecular collisions.

Bonhoffer and Harteck used a simpler and more rapid method for following the change of state of the hydrogen under different conditions. By measuring the change of resistance of a heated wire in the presence of the gas, the changes in the heat conductivity of the gas, which varies with the specific heat, were easily followed. We have already referred to their experiments of passing hydrogen through charcoal at low temperature and of the effect of the electric discharge. The results of the beautiful experiments of Bonhoffer and Eucken afford a complete and striking proof that hydrogen under ordinary conditions is composed of two sets of molecules which are transformed into each other so slowly that they may be regarded in a sense as two distinct gases differing in specific heat and conductivity. The specific heat of $\alpha$-hydrogen at low temperature is greater than that of $\beta$-hydrogen A large quantity of heat is given out in the passage of $\beta$- into $\alpha$-hydrogen At very low temperatures, the heat evolved in this transformation is greater than the heat of volatilisation of liquid hydrogen.

It may be of interest to note that the peculiar behaviour of hydrogen might have been discovered long ago, for no new experimental knowledge or technique is involved. Attention, however, was only directed to this subject by the failure of existing theories to account for the variation of specific heat of hydrogen with temperature The development of wave mechanics threw new light on this problem and a happy suggestion, based on this theory, was found to fit in well with the observations on the specific heat. Following this clue, the question was attacked experimentally by several different methods, with results in complete accord with the predictions of theory.

## Cinchona in the British Empire.

THE value of the cinchona tree (*Cinchona Ledgeriana*) as a source of quinine is common knowledge, but the considerable work undertaken by British medical officers in the past in making use of the product of this tree as a preventive against malaria is not so well known The cinchona tree was introduced into both India and Java between the years 1854 and 1864 Prior to about 1880, the world's supply of cinchona bark was obtained from the native forests in Ecuador, Bolivia, and Peru It was only after the export of bark from these regions could no longer be relied upon that attempts were made to grow cinchona elsewhere The British were amongst the first to succeed in bringing the tree under cultivation The pioneers were such men as Weddell, Hasskarl, Markham, Ledger, and others, and it was by their efforts that the establishment of important supplies of the drug became a practical proposition.

The early attempts to cultivate the cinchona tree met with considerable success, and private persons took up the business as a commercial proposition In the early days of cultivation, experiments were made in India, Burma, Ceylon, Malaya, the Sudan, Jamaica, Trinidad, St Helena, Mauritius, Australia, and New Zealand, but these experiments were not always followed up to a definite conclusion. In Ceylon and India the efforts were successful, but private planting was soon given up and the Government has been mainly responsible for the supplies Within the Empire, therefore, at the present day, India is the only country where cinchona is grown on a large scale. There are Government plantations in the Nilghiris in the south, in the Darjiling district in Bengal (perhaps the best known), and a more recently developed one in Burma. There are also quinine factories both in the Bengal and Madras Provinces.

A recent paper by Dr J. M. Cowan, of the Indian Forest Service and officiating Director, Botanical Survey of India, and Superintendent of Cinchona Cultivation in Bengal, entitled "Cinchona in the Empire: Progress and Prospects of its Cultivation" (*Empire For. Jour.*, vol. 8, No. 1 (1929)), discusses the present position of the cinchona and the future prospects of its cultivation.

The enormous importance to the human race within the Empire of the perpetuation of supplies of quinine will become evident when the question of malaria prevention is considered. We have within the Empire a large proportion of the malarial tracts of the world. Prof Müller of Cologne estimates that some 800,000,000 people suffer from malaria; and according to Sir Ronald Ross there are 2,000,000 fatal cases every year. It is further estimated by Dr. Andrew Balfour that the direct loss sustained by the British Empire due to sickness and death caused by malaria is in the neighbourhood of between £52,000,000 and £62,000,000 per annum.

Apart from financial considerations, it will be apparent that the responsibilities of the British Empire in this question of malaria prevention or reduction are heavy. The question has become an international one, and an organisation for anti-malarial work has been set up by the League of Nations The policy of this organisation is primarily the quinisation of affected populations. Hence the cultivation of the cinchona tree becomes a question of first importance. It is to a consideration of this matter that Dr. Cowan's paper is devoted

In India, then, the cultivation of cinchona is confined to Government activities It was not until 1910-11 that a similar problem had to be faced in Java Conferences were held, and manufacturers in Holland and growers in Java came to an agreement by which profits were to be shared and by which prices could be maintained at a level which would show satisfactory returns The disaster which threatened the Java plantations was averted to a great extent by the adoption of this policy; and supplies are now available for the world demands That the action taken in Java was thoroughly practical, a comparison between the two countries readily demonstrates They commenced to give attention to the question about the same time and the facilities in both regions were abundant. Yet Java now produces well over 90 per cent of the world's supply of cinchona bark and India only 4 per cent A very small percentage of the bark utilised comes from South American forests The production in India represents only about one-third of the amount actually consumed in the country itself. She is therefore at present not only unable to supply her own demands but also, in common with the rest of the world, is dependent upon the Dutch plantations in Java.

Dr Cowan explains one of the problems which has so far guided the cultivation of cinchona. "It is a well-known fact that to grow cinchona on the same land for a considerable number of years is a difficult and hazardous undertaking, for the first crop, in some manner not altogether understood, renders the soil, at least temporarily, incapable of producing a satisfactory second crop. As long as there is an unrestricted area of forest land the above factor seems of little consequence, but it makes itself felt more and more as the years go on and there is an increasing shortage of land carrying virgin forest."

Dr. Cowan discusses the methods of growing the crop, for details of which the inquirer is referred to his paper. Harvesting the bark commences in a block from about the fourth year, the material consisting of prunings and thinnings. The crop is reaped, the trees being uprooted so as to obtain the maximum of bark, in about the tenth year. The bark is removed, dried, stored, and then passed on to the quinine factory.

Two problems, in the author's opinion, demand urgent solution: the first is to find additional suitable land, an investigation in which other parts of the Empire should join; and the second is to enhance the output per unit of area Research work is also

necessary with regard to particular strains which yield high percentages of quinine

The price of quinine at present is very high—£1 9s. 6d. per lb —so high as practically to prohibit extensive anti-malarial measures On this subject the Royal Commission on Agriculture in India in its report (1928) stated "If India is to embark on any large campaign for fighting malaria, we are convinced that it will be first necessary to reduce considerably the price of quinine within India, and this can only be effected if India is self-supporting in production. To achieve this self-sufficiency a considerable extension to the present area under cinchona will be required . . We are satisfied that, in view of the great importance of extending cinchona cultivation and cheapening quinine, much more scientific investigation is called for than has been undertaken in the past"

Dr Cowan has done well in summarising the present position and in pointing out the great importance to a large section of the human race of the development of quinine production.

## Obituary.

### SIR ARCHDALL REID, K.B.E.

SIR ARCHDALL REID, whose writings on heredity aroused considerable interest among the medical and general public between 1900 and the outbreak of the War, died suddenly on Nov 18, at Southsea, at sixty-nine years of age.

Sir Archdall Reid was born at Roorki, N W Provinces, India, on April 7, 1860, and was the only son of Capt. C A. Reid of the 20th Bengal Native Infantry, and therefore originally in the service of the Hon. East India Co. He was in his earlier years educated privately, and then studied medicine in the University of Edinburgh, where he took the degree of M B. For some years after that he led a roving and adventurous life in India, New Zealand, the Pacific, and America, before settling down to general practice at Southsea He there devoted most of the hard-earned leisure which his professional work left him to the study of heredity, and published several volumes of considerable length on the subject, as well as articles and communications to NATURE. The books are. "The Present Evolution of Man", 1896; "Alcoholism, a Study in Heredity", 1901, "Principles of Heredity", 1905; and "Laws of Heredity", 1910. These writings show that their author possessed an active, independent, and original mind and much ingenuity, but unfortunately the want of a first-hand practical and experimental knowledge in biology prevented him from fully appreciating the technical points of his subject His point of view was that of the medical man, and he based his arguments chiefly on his knowledge of human disease and immunity

Sir Archdall's general views of heredity and evolution were adopted from Weismann He assumed that the differences between organisms were in general adaptive, and that evolution was due to natural selection acting on spontaneous variations, the effects of external stimuli never being inherited. He relied too much on verbal subtleties, which when carefully examined only put what was described before in other words; for example, his distinction between characters developed under the stimulus of nutrition, and those developed under the stimuli of use and injury, which comes ultimately to the same thing as inherited characters and acquired characters. He waged hopeless warfare against the facts and conclusions of Mendelism, which were then arousing enthusiasm among many biologists One of his attempts to explain away the importance of the Mendelian results was obviously unreasonable Mendelism was just beginning to consider whether the differentiation of sex was not a Mendelian segregation, when Sir Archdall maintained that "Mendelian inheritance is a human creation, and the right interpretation appears to be that nature treats mutations, when man interferes and presents them to her, as sexual characters". The excuse for this is of course that the genetics of sex and the relation of sex-limited characters to hormones were not then understood as they are now

Many biologists, however, who reject the possibility of the effects of external conditions being inherited, would probably accept Sir Archdall's facts and conclusions concerning alcoholism and disease as perfectly sound. His view was that "susceptibility to the charm of alcohol" was an innate character and tends as such to be inherited in the same sense as the shape of a person's head; that, as in all innate characters, variation occurs in the tendency to intemperance in drinking alcohol, so that all degrees of it may be said to occur in any population. As in other cases, these variations are subject to natural selection, which means in this case that the worst drunkards are killed off or leave fewer children. The consequence is that peoples which have been exposed to the temptations of alcohol for the longest time are the most naturally temperate, while peoples who have had little or no experience of alcohol, when it is first introduced among them, drink without restraint. This, according to Sir Archdall Reid, is the explanation of the facts that in southern Europe, where the vine has been cultivated from early times, the people are temperate, and that northern peoples, such as Russians, Germans, and English, are more given to drunkenness. Similar arguments and conclusions were maintained by Sir Archdall with much ability and command of language with regard to resistance to disease. "Every race", he wrote, "is resistant to lethal disease in proportion to its past experience of it, but the resisting power is such that it can only have been evolved through Natural Selection."

Throughout the War, Sir Archdall served as medical officer and was made a K.B.E. in 1919.

J. T CUNNINGHAM.

## News and Views.

IT is with widespread regret that the news has been received of the destruction of the non-magnetic research vessel *Carnegie*, and the lamentable death of Capt. J P Ault, captain of the vessel, physicist, mathematician, and leader of the expedition, whose magnetic surveys extending over all the oceans since 1909 are known throughout the maritime world The vessel, a brigantine belonging to the Carnegie Institution of Washington, was refitted last year and equipped for oceanographic and meteorological work as well as for the magnetic survey, and was fitted with an auxiliary bronze petrol motor She had since completed half of the projected cruise of 110,000 miles when, on Nov. 30, refilling petrol in Apia Harbour, Samoa, an explosion occurred resulting in her total destruction. No other member of the scientific staff of eight received serious injury, from the reports yet seen The Carnegie Institution has furnished classic material relating to the magnetic variation, dip and ocean meteorology, from the previous expeditions of this vessel and her predecessor under the leadership of Capt. Ault During this cruise, data have also been obtained of the electric condition of the atmosphere at different levels, of wind velocities by means of pilot balloons, of atmospheric refraction, the intensity of solar radiation, temperature and humidity lapse rates above the sea In addition, much oceanographic data have been collected, numerous stations having been worked from top to bottom for temperature and salinity of the water, which will add to our present knowledge of the hydrodynamics of ocean currents in the North Atlantic and Pacific The nutrient salts, phosphates, and nitrates, necessary for and usually limiting plant life in the sea, have been studied, and the amount of minute plants and animals —plankton—estimated by means of hauls with fine-meshed nets. The work was being closely followed by the Admiralties, meteorologists, and marine biologists of many nations.

REFERENCE was made in NATURE of Nov 23, p. 814, to the press announcements of the award of the Nobel prize for physics for 1929 to the Duc de Broglie for his work on the undulatory theory of matter. This work was carried out by M. Louis de Broglie, a younger brother of the Duc de Broglie, and it appears that the award has been made to the former. Maurice François César, Duc de Broglie, it will be remembered, is himself a distinguished physicist who received the Hughes Medal of the Royal Society last year for his pioneer researches on X-ray spectra and secondary $\beta$-rays. Reverting to M. Louis de Broglie, it may be added that it was his work which led Schrodinger to his well-known equation which is the basis of attack of problems by wave mechanics. The first experimental verification that an electron behaves like a wave was made by Davisson, and Germer, who studied the scattering of electrons from a single crystal of nickel. They were working at the Bell Telephone Laboratories, Inc., New York, and reported their experiments in a letter which appeared in NATURE of April 16, 1927, p. 558; a more detailed statement appeared in the *Physical Review* for December 1927 The experiments of Prof G P Thomson and others on the subject were somewhat later, and different methods were adopted

DR A. B RENDLE, who retires from the post of Keeper of the Department of Botany in the British Museum in January next, was educated at St Olave's Grammar School and St John's College, Cambridge, and entered the Museum in 1888 By this time the collections which had been transferred from Bloomsbury in 1880 had been arranged, but there was still much to do, and Dr Rendle then and there began his interest in the public gallery and index museum, the exhibits in which have been mainly his work. His systematic studies deal mainly with Monocotyledons, Apetalæ, and Gymnosperms, on which he has published more or less continuously for the past forty years, but he has also done critical work in other groups, for example, Convolvulaceæ and Urticaceæ. He was appointed keeper in 1906 in succession to G R M Murray, who retired through ill health before he was fifty During Dr Rendle's tenure of office the Department has probably doubled in size in every way He was elected a fellow of the Royal Society in 1909

THE keepership of a natural history department usually carries with it a number of non-official obligations, and Dr. Rendle has taken a pleasure in entering into these to the full. Amongst other activities, after serving on the Council of the Linnean Society, he became botanical secretary from 1916 until 1923, and president from 1923 until 1927. During this last period, the Society was undergoing certain changes which might have made for difficulties with a less experienced president. For the period 1894–1906, Dr. Rendle was head of the Botanical Department at Birkbeck College, and has always taken an interest in the teaching of botany, academic and otherwise. He has been president of several societies—South-Eastern Union of Scientific Societies, South London Botanical Institute (almost from its start), Quekett Microscopical Club—and has been honorary professor of botany to the Royal Horticultural Society for some years. After J. Britten's death in 1924, he added to his many duties that of editor of the *Journal of Botany*. His principal works are "The Classification of Flowering Plants", of which Vol. 1 appeared in 1904 and Vol. 2 in 1925, and the "Flora of Jamaica", with the late W. Fawcett; this latter began in 1910, and it is to be hoped that Dr. Rendle will be able to complete it. After his long reign as keeper he will doubtless appreciate the botanical opportunities which a well-earned retirement brings.

MR. J. RAMSBOTTOM, deputy keeper of the department of botany since Nov. 1927, who succeeds Dr. A. B. Rendle as Keeper, entered the Department in 1910, after studying at Cambridge and Manchester. He was appointed to the section on fungi, which previously had not received the attention due to its importance. During the first part of the War, many

investigations were carried on in the Department, and later Mr. Ramsbottom was seconded to the War Office for service as protozoologist in Macedonia. His civilian days came to an end after about a year's service, and he was attached to the R.A.M.C., he was mentioned three times in despatches and awarded the M.B.E. and O.B.E. The cryptogamic herbarium at the Museum has become more and more important since the War, and is likely to continue. Mr. Ramsbottom was president in 1924 and is general secretary of the British Mycological Society, he has been botanical secretary of the Linnean Society since 1923, and this year he is president of the Quekett Microscopical Club.

THE second of three windows placed in St. Ethelburga's Church, Bishopsgate, to the memory of the seventeenth-century navigator, Henry Hudson, was unveiled on Nov. 28 by Mr. A. Halsted, the American Consul-General in London. This window, like the first, is the gift of certain citizens of the United States. In it Hudson is shown exploring the Hudson River in the *Half Moon*, finding Red Indians welcoming his approach. His first voyage was made for a company of London merchants, and it was in St. Ethelburga's that Hudson and his crew made their communion on April 19, 1607, before going aboard. Nothing is known of him prior to that, but in the course of the succeeding years he made four voyages, first to Greenland and Spitsbergen, then to the coast of Novaya Zemlya, thirdly to the Atlantic coast of America, during which he explored the Hudson River a little farther than Albany, and lastly to Hudson Bay. He was not the discoverer of either the river, the straits, or the bay which bear his name, but he added much to the geography of North America. Preparing to return to England in the spring of 1611, a part of his crew mutinied, and Hudson with his son and seven others were turned adrift in an open boat, after which nothing more was heard of them. Like many other voyages, Hudson's were undertaken with the view of finding a northern passage to the East Indies.

DURING the recent meeting of the International Institute of African Languages and Culture, held in London, the members were entertained by the Government at a luncheon given at the Hotel Cecil on Nov. 28, when a large number of distinguished guests was present. The occasion was made notable by a speech from Lord Passfield, in which he paid a tribute to the value of anthropology in the administration of the affairs of a backward people. Every young man, he said, who goes out to take part in administrative work ought to receive very definite training in anthropology, and he went on to express the hope that the beginning which has been made in giving training of that kind may be increased and intensified. A pronouncement of so emphatic a character, coming from the head of the department in charge of the Dependencies in which the officers to whom he referred will have to carry on their work, cannot fail to stimulate the study of native institutions and intensify the interest taken in them by those who are preparing to enter the Colonial services.

IT may not be inapposite to point out, however, that facilities for training probationers for the Colonial services have long been provided by universities and other educational institutions of Great Britain, which have repeatedly urged upon those in authority the desirability and, indeed, the necessity that administrative officers should receive a grounding in anthropology before taking up their duties. Prof. Westermann, a director of the Institute, in thanking Lord Passfield for his encouraging speech, pointed out the utility of such an organisation as the Institute to traders, planters, settlers, administrators, educationists, and missionaries in helping them to the solution of the problems with which they are surrounded. It is unfortunately only too true that while, as Prof. Westermann pointed out, the vital interest in Africa is the African, the whole aspect of his life is threatened by the white man's activity. It cannot be too widely realised that only a sympathetic and well-informed administration, with a policy based on a study of native custom, can solve the problems upon which depend the whole political and economic future of Africa.

COMMANDER R. E. BYRD on Friday of last week made a successful flight from the Bay of Whales on the Ross Barrier to the South Pole and back. He returned in the early hours of Saturday morning, having accomplished the distance of about fifteen hundred miles without mishap. On the return journey, a descent was made for refuelling at a depot of petrol which had been placed on the Barrier 400 miles south of his base. Details of the flight and Commander Byrd's discoveries are still lacking, but his course, if straight, must have been approximately that of Captain Amundsen in his sledge journey in 1911. In order to cross the lofty Queen Maud Ranges, Commander Byrd must have risen to more than 10,000 ft. At that altitude, if the weather was clear, he should have seen the unknown eastern edge of the Barrier, hinted at by Amundsen, and also the course of the Queen Maud Ranges to the south-east. Sir Hubert Wilkins is also in the Antarctic at his base at Deception Island, South Shetlands, where he is preparing for his contemplated flight westward along the Pacific edge of the Antarctic continent to the Ross Barrier.

WHILE it may be one thing to have proved an oil-field to be worth working from a commercial point of view, it may be quite another matter to exploit it successfully if questions of title to concessions, exploration and development rights, royalties, refining practice, employment of nationals, and so on, founded on insecure legal codes, are constantly raised at the slightest whim of governments. Such matters of higher policy, particularly in the case of companies operating in foreign territories, call for administrative ability of no mean order, and few, even within the oil industry, appreciate the extent of the diplomatic workings necessary, both at home and abroad, to secure uninterrupted operations. Instance the country inexperienced in oil production suddenly finding itself the possessor of newly discovered petroleum resources; in the general scramble for titles, probably exaggerated

optimism, and public dreams of quickly gotten wealth, a number of laws, loose in construction, impossible of rational interpretation, are passed; as time goes on and developments promise well, various conditions and petty restrictions are imposed, either with the view of diverting more money into the national exchequer, or of giving the government (more probably its favoured officials) active participation in the affairs of the company.

A KIND of communal possessive instinct is manifest, strengthened in proportion as the industry grows; the attitude of disinterested complacency at the pioneer stage, while the oil company was spending money and earning none, rapidly changes to one of mere tolerance and desire to profit the moment success is assured; the public is urged to protect its rightful interests; the cry of nationalisation of internal resources is raised, and everything done to make conditions as difficult as possible for the harassed company officials. Usually, the proportion of local staff employed is compulsorily raised until the company finds itself flooded out with superfluous, inefficient labour; then long and protracted negotiations are undertaken between government and executive to find a policy which will placate the former and yet make it possible for operations to continue on a paying scale. These are among some of the more complex problems propounded by immature oil legislation, and Sir Arnold Wilson was right when he stated in a paper read before the Institution of Petroleum Technologists on Nov. 12 that unsuitable laws retard, and good laws encourage, developments of the oil industry, especially in countries such as Central and South America, where the evils of defective law and inconsistent legislation have often had to be reckoned with by the concession hunter or lease-holder.

THE compound for which the handy abbreviation of 'S.U.P. 36' has fortunately been adopted, is the symmetrical urea of para-benzoyl-para-amino-benzoyl-amino-naphthol 3·6 sodium sulphonate; it was introduced by McDonagh, in the belief that it would prove of value in therapeutics by stimulating the tissues of the host to overcome various acute microbial infections. R. M. Pearce (*Brit. Med. Jour.*, Oct. 12, pp. 663 and 831; 1929) has recently described its use in influenza: in a series of more than eighty cases, every alternate patient was given 0·005 gm. S.U.P. 36 intramuscularly when the onset had occurred within the preceding forty-eight hours, and a further dose of 0·0075 gm. if necessary on the fourth day. The uninjected cases served as controls. It was found that the duration of the pyrexia, of the headache and muscular pain, as well as the total duration of the illness, were about halved by the injection of S.U.P. 36. J. S. Hall (*ibid.*, p. 831; 1929) has also found it of value, in doses up to 0·01 gm., in a variety of conditions, including the severe vomiting of pregnancy, acute pyelitis, cystitis and mastoiditis, osteomyelitis and broncho-pneumonia in children. The compound, however, does not act as a preventive if injected when no acute infection is present. Further details of its action and uses are given in a little brochure published by The British Drug Houses, Ltd., Graham St., London, N.1, who prepare the compound, manufactured by British Dyestuffs Corporation, Ltd., for medical use: it is issued ready for intramuscular injection in isotonic solution in ampoules or rubber-capped vaccine bottles.

THE maximum power which may be radiated by broadcasting stations was limited to a hundred kilowatts by the International Consultative Committee at the Hague Conference. An unfortunate consequence of this decision is that this enormous power is regarded by many as the standard which should be aimed at when constructing a national broadcasting station. Some of the European States which are now constructing broadcasting stations are proposing to use very high powers, notwithstanding that the use of crystal receivers is now dying out, and that the number of listeners using valve sets is rapidly increasing. So far as reception in Britain is concerned, there is little interference at present by foreign transmissions, but in the immediate future when more giant stations are constructed abroad trouble due to this cause will be serious.

IN the early days of broadcasting, both in Great Britain and abroad, the stations provided about one kilowatt to the aerial. According to the *Wireless World* for Nov. 27, Germany was the first country to increase the power of its stations. As other countries began to build transmitters the natural tendency was to equal or raise the four kilowatt standard set by Germany. Five and ten kilowatt broadcasting stations became quite common. Germany is now considering a scheme for installing new high-power stations in addition to the present transmitters, and proposes to combine them into groups. The lower-power transmitters will operate on the national wave-length in conjunction with a high-power station. If this scheme is adopted, the German transmitters will once more dominate Europe, and other States will be stimulated to follow the German example. As a rule, the higher the power of a station the more costly is its construction. It will be very difficult, therefore, to modify European broadcasting in the future should this become necessary, owing to an excessive number of high-powered stations.

DURING last year immense strides were made in the development of broadcasting in Japan. Six modern broadcasting stations have been opened, with the idea of bringing as many listeners as possible within crystal range of some station. The new stations are each rated at 10 kilowatts, and are housed in new buildings so as to leave the original transmitters still available in case of emergency. All call signs in Japan are given out in English, and consist of four letters commencing with J.O. and ending with K. For example, J.O.A.K. stands for Tokyo, and J.O.C.K. for Nagoya. The entire broadcast wave-length lies between 350 and 400 metres. We learn from *Electrical Communication* for October that the equipment of all the stations has been imported from England. Sendai (J.O.H.K., 389·6 m.) is the chief town in the north of the main island. It is here that Prof. Honda's laboratory for metallurgical research is situated.

Every physicist and electrician knows the important work that he has done in connexion with cobalt magnet steel, now known as 'K S steel', work that has proved a great boon to the designers of electrical apparatus. For listeners outside Japan this station is the most favourably situated New Zealand has reported excellent reception Owing, however, to the mountainous nature of the country, the signal strength from any station varies considerably with its locality. There are one or two large cities situated quite close to a broadcasting station where reception is sometimes very poor It is probable, therefore, that it will be found advisable to supplement the present main stations by small relay stations of two kilowatt capacity, when the demand gets greater.

THE study of the habits and psychology of the great apes must always be of supreme interest for their human relatives Such study in the Old World has been provided for by the French station at Kindia, in Africa, where the apes can be observed in conditions approaching those of their natural life and in a favourable climate According to a *Daily News Bulletin* issued by Science Service, Washington, D C., a similar station, in which natural conditions will be copied so far as possible, is to be created on a 200 acre plot near Orange Park, Florida, under the auspices of Yale University This great scientific ape-breeding farm has been made possible by a gift of 500,000 dollars from the Rockefeller Foundation.

UNDER the Boiler Explosion Acts of 1882 and 1890, the Board of Trade is authorised to hold inquiries into explosions of steam boilers and steam apparatus in Great Britain, and 62 such inquiries were held during 1928. Some of the accidents resulted in injuries to persons, of whom seven died, and also in great financial loss. The explosions included accidents to marine and land boilers, steam pipes and valves, bakers' steam-heated ovens, economisers, drying cylinders, etc At the beginning of the present year, during the severe frost in February, many explosions of heating apparatus took place, and those which occurred in churches, schools, and other institutions were the subject of inquiry. In every case it was shown that ice forming in the pipes had choked the system and that the safety arrangements had become inoperative. Explosions in private houses were reported in the Press at the time, and it is probable there were a large number of such failures. With the approach of winter, it cannot be too strongly impressed upon all who have charge of steam and hot-water heating systems that the safety valves or safety discs should be placed on the boilers themselves and not in the heating pipes at some distance away. Practically every accident to heating apparatus which has come to our notice would have been prevented had the safety appliances been so placed.

AT a recent meeting of the New York Electrical Society, Mr. E W. Stearns gave some particulars of the great suspension bridge now being built over the Hudson River, which will connect New York City and New Jersey. The bridge will be ready for use in 1932, and when completed will be by far the largest suspension bridge in the world, having a span between the towers of 3500 feet. The two towers, each 635 feet high, will carry a weight in cables alone of 28,000 tons, the cables containing more steel wire than the next seven largest suspension bridges combined, the Brooklyn, Williamsburgh, Manhattan, Detroit, Philadelphia, Bear Mountain, and Poughkeepsie bridges. Made of steel wire with a tensile strength of 230,000 pounds per sq in, each of the four main cables will contain 26,474 wires made up of 61 strands of 434 wires each. To squeeze the cables into circular shape a squeezing jack with hydraulic cylinders will be placed around the cable and this will bring a pressure of 400 tons to bear on the cable Sufficient elasticity is incorporated into the design of the towers and the bridge to allow of a sag of ten feet, but the sag under normal loading will not be more than four feet

THE twelfth of the series of the Rockefeller Foundation, New York, devoted to "Methods and Problems of Medical Education", is given up to articles by specialists in charge of "Departments and Institutes of Rontgenology and Radium Therapy" This is a very valuable compilation, and it appears opportunely when big movements are afoot for the development of radiology in medicine. The book is essentially a presentation of how this subject is dealt with the world over, the various departments and organisations are described in detail with lists of personnel and occasionally estimates of cost of running such departments Such a publication has a twofold value. In the first place, the reader can gather the extent to which radiological methods are at present used in everyday diagnosis and treatment of patients, and in the second place, those who are concerned with the initiation or development of departments of this kind will have at their command a mass of information which should be of the greatest scientific and economic service to them.

AN account of the modern methods of fishery research as undertaken by the biological laboratories and fisheries institutes on the coast of the North Sea and Baltic is given in Lief 12, Teil $1.e_1$ (Fischereibiologie by W. Schnakenbeck) of Grimpe and Wagler's "Die Tierwelt der Nord- und Ostsee" (Leipzig: Akademische Verlagsgesellschaft m b H., 1928). After an introduction and brief historical survey, the author proceeds to describe the various nets, dredges and trawls in use for both fishes and invertebrates, including plankton nets and water bottles for the smallest organisms, and, for sampling the bottom, the 'grab'. The most important methods of research are then briefly noted, particularly age-determination and the marking of fishes, and the study of animal communities at the bottom in connexion with fish food, besides method of plankton research. There are good illustrations of the research vessels employed by the laboratories and institutes in Heligoland, Denmark, Sweden, Norway, Scotland, and England, also of the nets, dredges, water bottles, and grab, figures showing representative bottom communities and numerous maps and diagrams. The whole forms a useful introduction to methods of fisheries research.

THE Thomas Lowe Gray Lecture of the Institution of Mechanical Engineers will be delivered on Jan 3 at 6 P.M by Eng Vice-Admiral R W Skelton, who will take as his subject "Progress in Marine Engineering"

LORD BLEDISLOE, president in 1922 of Section M (Agriculture) of the British Association and Parliamentary Secretary to the Ministry of Agriculture from 1924 until 1928, who has for many years identified himself with agricultural interests, has been appointed Governor General of New Zealand in succession to General Sir Charles Fergusson, whose term of office expires early next year

PROF G ELLIOT SMITH will deliver a lecture on Java in the Great Hall of University College, Gower Street, W C 1, on Monday, Dec 9, at 5 30 p m Prof Elliot Smith visited Java last summer when, acting as one of two representatives of the British Government, he attended the Pacific Science Congress held at Batavia in May last. The lavish hospitality of his hosts gave Prof Elliot Smith every opportunity of seeing whatever was worth seeing in their colony He visited the principal sites of archæological interest, saw something of life in the native protectorates, including the courts of the sultans, and also visited the island of Bali, interesting from the peculiar nature of its people, its culture, and its religious ceremonial Prof. Elliot Smith's lecture will cover an attractive and, to the average Englishman, little-known field

THE first S M. Gluckstein Memorial Lecture of the Institute of Chemistry will be delivered by Dr Leslie H. Lampitt at the Institute on Friday, Dec 13, at 8 P M. Dr. Lampitt has chosen for his subject "The Chemist and Commerce". The late S M Gluckstein, a director of Messrs. J. Lyons and Co., Ltd., read before the London and South-Eastern Counties Section in October 1927 a paper entitled "Chemistry and Dividends", in which he gave an account of the development of the chemical staff and laboratories of his company, illustrating the bearing of science, and particularly chemistry, on the management of a large industrial undertaking. The laboratory staff of the company is now 72 chemists and assistants, who are accommodated in the laboratories at Kensington, opened this year, of which Mr. Gluckstein, who died on Aug. 29, 1928, did not live to see the completion. In memory of the Director who had taken so great an interest in their work, the staff of the laboratory, of which Dr. Lampitt is the head, offered the Council of the Institute a sum of approximately £200 to administer this fund for the provision of an annual lecture, the purpose of which is to show the bearing of science on industry, particularly in various fields of chemical activity. The lecture will be open to members of other societies and to the public.

WE have received vol. 6 (1928) of the *Transactions of the Institution of Chemical Engineers*. This contains the presidential address of Sir Alexander Gibb on the economics of power as applied to chemical engineering, papers on magnetic separation, the combustion of powdered coal, treatment of beet sugar factory effluents, fluid jets, electrodeposition of rubber, and several papers on drying.

FOR the hundred and tenth annual meeting in Davos of Schweizerische Naturforschende Gesellschaft a 'Festschrift' of some twenty articles was produced (B Schwabe and Co, Basel). All the articles have a bearing on Davos and they are of a varied nature Several are meteorological, one of them dealing with the intensity of the insolation. Others treat of the geology, flora, birds, and butterflies of the district Two articles are descriptive of the research institutions of Davos and five treat of medical subjects germane to the district The volume has a number of photographic illustrations

THE International Baltic Geodetic Commission held its fourth session at Berlin in September last year. All the States adjoining the Baltic except Russia were represented The proceedings are now published in *Verhandlungen der Baltischen Geodatischen Kommission* (Helsinki, 1929). The daily proceedings are recorded, and several of the more important papers are printed at length with maps All of the States concerned provided papers on some aspect of their geodetic work, and several States, notably Denmark, contributed accounts with charts of the present state of triangulation The next meeting of the Commission is to be in Copenhagen in 1930.

THE Department of Agriculture and Stock of Queensland has recently published a useful manual entitled "Pests and Diseases of Queensland Fruits and Vegetables", by Messrs R. Veitch and J. H. Simmons This handbook supplies the want for a trustworthy account of the commoner pests of Queensland fruits and vegetables and, at the same time, provides a short introduction to the elements of entomology and plant pathology. It can be recommended as a good practical account of the subject and its value is much enhanced by sixty-one excellent plates, both black-and-white and coloured, which have been executed in Australia. The book bears the name of the Government Printer, Brisbane, 1929, but no price is stated.

THE International Society of Experimental Phonetics has arranged for the following official organs to be sent to its members at reduced prices: *Zeitschrift fur Experimentalphonetik*, quarterly, 5s. (instead of 10s.), *Comptes rendus de la Société Internationale de Phonétique expérimentale*, annually, no charge; *Bulletin of the International Society of Experimental Phonetics*, annually, 1s.; *Sprachneurologische Mitteilungen*, quarterly, 4s. (instead of 6s.); *Archives Neérlandaises de Phonétique expérimentale*, annually, 6s 7d. or 4fl. (instead of 5fl); *Archiv fur Psychiatrie u. Nervenkrankheiten*, 20 per cent reduction All persons—as well as libraries, institutes, corporations, business firms, etc.—who are interested in experimental phonetics may become members of the Society. Only experimental phoneticians of acknowledged standing may be members of the council. Applications for membership, accompanied by the fee

of 10s., may be sent to the president, Prof. E. W. Scripture, 25 Howard Road, Coulsdon, Surrey, England.

MESSRS. Dulau and Co., Ltd, 32 Old Bond Street, W.1, have just issued Catalogue No. 172 of upwards of 2000 second-hand books of science classified under the headings of horticulture, plant collecting, herbals, and general botany; local floras; geology, mining, palæontology, etc.; ornithology; general natural history, including entomology, mammalia, fishes, invertebrata, mollusca, etc.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned —A lecturer in engineering at the Kenrick Technical College, West Bromwich—The Director of Education, Education Offices, West Bromwich (Dec 14). A chemical laboratory assistant at the Royal Arsenal, Woolwich—The War Department Chemist, B 47, Royal Arsenal, Woolwich, S E.18 (Dec 14). Temporary inspectors under the Department of Agriculture for Scotland—The Establishment Officer, Department of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh (Dec. 14). A part-time lecturer in mathematics at Birkbeck College—The Secretary, Birkbeck College, Fetter Lane, E.C.4 (Dec. 16). A Paterson research scholar in the Cardiographic Department of the London Hospital—The House Governor, London Hospital, E.1 (Dec. 17) A guide-lecturer and professional assistant at the Science Museum, South Kensington—The Director and Secretary, Science Museum, South Kensington, S W 7 (Dec 21). An investigator at the Royal Aircraft Establishment for research work in connexion with the electro-deposition of metals—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (quoting A. 388) (Dec. 21) A permanent inspector under the Department of Agriculture for Scotland—The Establishment Officer, Department of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh (Dec 21). Two assistant entomologists under the Division of Economic Entomology of the Commonwealth Council for Scientific and Industrial Research, for work on the Buffalo Fly Problem—F L McDougall, Australia House, Strand, W C 2 (Dec. 30) A principal of the Central School of Arts and Crafts, Southampton Row, W C 1—The Education Officer (T 1), County Hall, Westminster Bridge, S.E 1 (Jan. 20). A resident research fellow at Lady Margaret Hall, Oxford—The Hall Secretary, Lady Margaret Hall, Oxford A lecturer in geography at St. Mary's College, Strawberry Hill—The Principal, St. Mary's College, Strawberry Hill, Middlesex. A chief lecturer in the Electrical Engineering Section of the Engineering Department of the Halifax Municipal Technical College—The Principal, Municipal Technical College, Halifax. An evening lecturer in refrigeration at the Borough Polytechnic Institute—The Principal, Borough Polytechnic Institute, Borough Road, S E 1 A temporary junior assistant for a Government Laboratory—Z. E., c/o Charles Barker and Sons, Ltd., 31 Budge Row, E.C 4.

## Our Astronomical Column.

**Solar Activity**—The temporary revival of solar activity shown during the last few weeks has been continued by the recent appearance of two other large groups of spots. One of these was a big regular spot of about 1000 millionths of the sun's hemisphere, and was therefore a conspicuous naked-eye object This spot was the return of a complex stream, No 13 in the list given in NATURE, Nov 9, p. 737. The other group (No. 15) represented a new outbreak in the place of No. 12. The following table is continued from the note in our issue of Nov. 9:

| No. | Date on Disc | Central Meridian Passage | Latitude. | Max Area. |
|---|---|---|---|---|
| 15 | Nov 21–Dec. 4 | Nov. 27 9 | 13° N. | 900 |
| 16 | Nov. 24–Dec. 6 | Nov. 30 3 | 16° N. | 1000 |

**Spectroheliscope at Greenwich.**—A spectrohelioscope is being installed at the Royal Observatory, Greenwich. The instrument, which has been lent by the Mt. Wilson Observatory, is one of several constructed according to Dr. G E. Hale's design in the observatory workshops at Pasadena. A description of this ingenious adaptation of the spectroscope, and the observations it is possible to make with it, will be found in various contributions made to NATURE by Dr. Hale during the past few years (see July 3, Supplement, 1926; May 14, 1927, p. 708; April 28, 1928, p. 676).

**Jupiter.**—Fourteen months ago Rev T. E. R. Phillips announced the appearance of a series of small spots in the southern hemisphere of Jupiter which had such a high westward velocity that their apparent period of rotation was $9^h$ $59^m$, the highest value on record. In *Circular* No. 79 of the British Astronomical Association, he describes some recent observations made by Mr. A. Stanley Williams at St. Mawes, Cornwall They refer to some spots on the south edge of the North Temperate belt, which have the abnormally short rotation period of $9^h$ $48^m$ $49^s$, indicating a rapid eastward motion on the planet's surface. There is, therefore, a difference of more than $10^m$ between the rotation periods of the spots of 1928 and the present spots. It is further noted that spots in the same latitude as the present ones were seen in 1880, 1891, 1892. These also gave an unusually short period of rotation.

**Stellar Spectroscopy at Dominion Observatory, Victoria.**—The *Publications* of the Dominion Observatory, vol. 4, Nos. 12 and 13, contain two interesting researches on spectroscopic binaries. No. 12, by R. N. van Arnam, treats of the star $\beta$ Cephei, which is of mag. 3·3, type *B*1. The period is 0·1904843 day. Treating the change in radial velocity as due to orbital motion, the orbit elements appear to have changed notably between 1919 and 1922. The semi-amplitude of the velocity range changed from 13·1 to 9·5 km./sec., the difference being eight times the probable error; $a \sin i$ changed from 34,043 km. to 24,606 km The symmetry of the velocity curve indicates that if the change in radial velocity arises from orbital motion the orbit is appreciably circular.

No. 13, by W. E. Harper, describes the orbits of two spectroscopic binaries of unusually high eccentricity Boss 4177, mag 5·72, type *A*o, has a period of 4·951 days and eccentricity 0·511; the semi-amplitude of the velocity range is 16·28 km./sec.; only one spectrum is visible. H.R. 7338, mag. 6·19, type *A*o, shows the secondary spectrum faintly; the minimum mass of the system is twice that of the sun, divided in the ratio 1·180 to 0 844; the period is 10·3932 days, and the eccentricity 0·520.

## Research Items.

**Anthropology and Blood-Groups.**—In *Man* for November, Dr H Woollard and Dr J B. Cleland discuss the evidential value of the blood groups in anthropology as an indication of race Their view differs fundamentally from that now generally held, and is primarily based upon investigation of the blood-group in the Australian aboriginal. It has been observed that the *A* group is the most frequent in the aborigines who belong to Central and South Australia, and when the results are those of natives whose purity is above suspicion, it is found that the Australian aboriginal contains no *B* factor. On this evidence it has been suggested that the Australian has Nordic affinities, while other investigators, finding the evident discrepancies in the group percentages of closely related peoples, have been tempted to ignore blood-groupings. Obviously percentage grouping is only one racial character which no more suffices to distinguish race than any other single character. Taking the evidence afforded by the blood-grouping of the anthropoids, the American Indian and the Australian, it is here suggested, contrary to the view hitherto put forward, that the original human family contained all four groups Instead, then, of this single anthropological character being expected to stamp each variety of man, the problem is rather to explain how the existing varieties of man obtained their present percentage, and indeed how a human type escaped an inheritance of all four groups and comes to possess one only Thus the high frequency of the *A* factor in the Australian aboriginal implies no close affinity with Nordic man, who also possesses a high percentage of the *A* factor. The constitution of a grouping such as that in the Australian would force the assumption that their ancestors started with this genetic constitution, that they were few in number, and that they have lived for a long period in isolation.

**Vaccination against Anthrax.**—In the current number (Vol. 62, Parts 6-10) of the *Rendiconti* of the Royal Lombardy Instituto of Sciences and Letters, Dr. Mario Mazzucchi describes the results of experiments on a new method of vaccination against anthrax. The procedure followed differs fundamentally from that used by Pasteur, as it employs, not attenuated anthrax bacilli, but virulent germs and spores. Only a single injection is made, and twelve days later immunity from the disease is so complete that the treated animal is able to withstand an injection of anthrax organisms sufficient to produce fatal results in control animals within 40-60 hours. The tests were made at both the Istituto Sieroterapico of Milan and the Stazione Sperimentale di Zooprofilassi in Rome, and were carried out on goats, sheep, and cows, always with the same result—that the new vaccine is far more efficacious than the three Pasteur vaccines with which it was compared. The observations made by Dr. Mazzucchi indicate that it is necessary in experimental work of this kind to bear in mind that the resistance of an animal to anthrax may be of any of the following forms: (1) Individual resistance, common to all animals, no matter what the species, (2) regional resistance, which appears to be the greater with animals accustomed to the wild state; (3) resistance from natural acquired immunity, not infrequent in animals which live in infected zones and may have contracted infection and undergone spontaneous cure; (4) a complex immunity consisting of type (3), reinforced by the slight action of an attenuated vaccine.

**Tidal Zone Fauna in Sand and Mud.**—Mr A. C. Stephen, in his "Studies on the Scottish Marine Fauna: the Fauna of the Sandy and Muddy Areas of the Tidal Zone" (*Trans R Soc. Edinburgh*, vol. 56, Pt. 2, No. 14, 1929), continues his examination of the fauna of the intertidal bays which was begun in the Island of Cumbrae in 1926 and is now extended to various other areas on the Ayrshire coast, Firth of Clyde, south coast of Moray Firth, Aberdeenshire coast, St Andrews Bay, and the Firth of Forth. Mollusks and polychætes are specially dealt with, only a few species being common and widely distributed: such are *Tellina tenuis*, *Nephthys cæca*, *Donax vittatus*, *Cardium edule*, and *Macoma baltica*. The two first are characteristic of clean sand, and, locally, also *Donax vittatus*, the two last living on muddy ground or black and strong smelling sand. In certain areas the two types intermingle, the nature of the soil evidently being an important factor when dealing with distribution Each species has a region of maximum concentration *Tellina tenuis* is almost always most abundant at low-water mark, gradually decreasing towards high-water mark, *Macoma baltica* and *Cardium edule* having their maxima between tide-marks A further research into the food of these invertebrates would be of great value, and it is to be hoped that this will be forthcoming

**Influence of Light on Larval Ascidians.**—Experiments with larvæ of *Symplegma viride* were made last year at the Tortugas Laboratory by Mr Caswell Grave. This year a note by the same author (*Year Book* No. 27 of the Carnegie Institution of Washington, 1928) shows the response to light stimuli by *Polyandrocarpa tincta*, a species closely related to *Symplegma*. The small larva is liberated in large numbers and its free-swimming period is relatively long (transforming in the course of a day under laboratory conditions) Experimentally, the majority of the larvæ can be induced to metamorphose and attach themselves in about 70 minutes by subjecting them soon after being set free to alternate periods of light and darkness, a typical instance being 25 or 30 one-minute 'doses' of light, each followed by a one-minute 'dose' of shadow. The light was ordinary diffuse light from the laboratory windows, allowed to come only from the east, other sources of light being blocked, and the experimental vessels were covered by tumblers wrapped in black paper for the period of darkness. Controls exposed to the same light but without periods of darkness took several hours to metamorphose The rhythmic alternation of the periods of light and darkness is of importance, intensity of light making little or no difference. The natural habit of the free-swimming larva is to swim up and down between the surface when it is light and the bottom when it is dark, until a "final stimulus to attachment and metamorphosis is released".

**The Trematode Family Schistosomidæ.**—This family is the subject of a useful and compact synopsis by E. W. Price (*Proc. U.S Nat Mus.*, vol. 75, Art 18, 39 pp., 1929), who has carefully assembled the descriptions of the known genera and species, has prepared keys for aiding their identification, and clear illustrations to show their diagnostic characters Three new genera are founded—*Heterobilharzia*, for some male worms from the mesenteric veins of the North American lynx; *Paraschistosomatium*, of which the female only is known from the portal vein of a bird from Texas; and *Microbilharzia*, from the mesenteric veins of North American birds.

**Encystment in Rotifers.**—David L. Bryce (*Jour. R. Micr. Soc.*, vol 49, Pt 3) records observations on

the encystment of three Bdelloid rotifers He states that no evidence of encystment exists in rotifers other than Bdelloids, but suggests that it is widespread in this order, and is correlated with the habits. A large proportion, probably the great majority, of Bdelloids have alternate periods of activity and of dormant existence according as the moss in which they live is wet or dry. So long as the moss is wet they are active and multiply, but when the moss begins to dry they retract their extremities within the central portion of their bodies, reducing their bulk as much as possible, and pour out a secretion which completely covers them and hardens to an air proof coating When the moss is again wetted by dew or rain, the coating is dissolved and the rotifer renews its activity. The author refers to the flimsy character of the envelope, "that it would afford any protection against desiccation is not known" He suggests that the reason why similar examples of encystment have not previously been detected is perhaps that few observers have kept these rotifers alive from day to day in almost minute quantities of water That the short supply of water was the reason for the encystment in these cases can scarcely be doubted

**Japanese Calcareous Sponges.**—Only six species of calcareous sponges had been recorded from Japan until Prof. Sanji Hôsawa took up the study of this special group, and now he has added fifty-one more species from this region, no less than forty-seven of which are new to science. Some of these have already been described by the author (1916, 1918), who in a recent memoir, "Studies of the Calcareous Sponges of Japan" (*Journal of the Faculty of Science*, Imperial University of Tokyo, Section 4, Zoology, vol 1, part 5, January 1929), revises what has been written by previous authors, and gives detailed descriptions of those forms which he has himself observed. The specimens were furnished by various collections from many localities, in depths ranging from shallow water to 572 metres Thirty four new species are described in this paper, and these are for the greater part preserved in the museum of the Zoological Institute of the Science Faculty in Tokyo There are twelve plates with photographs of the individual sponges, and beautifully executed coloured figures showing sections with details of the skeleton, and there are in addition many text figures of the spicules The new species include three *Leucosolenia*, one *Dendya*, one *Leucaltis*, one *Sycetta*, seven *Sycon*, one *Grantessa*, three *Vosmaeropsis*, two *Grantia*, two *Ute*, and thirteen *Leucandra*

**Origin of Cultivated Dahlias**—In an interesting paper, Mr W J. C. Lawrence (*Jour. Genetics*, vol 21, No 2) has given an account of genetical and cytological work on dahlias Mexico and Central America is the home of this genus Three species are found to be tetraploid ($2n=32$), while *D Merckii* has 36 chromosomes and *D variabilis*, the common dahlia, is confirmed as having 64 chromosomes, an octoploid number It was figured so early as 1615, and was probably grown as a garden plant in Mexico long before its introduction into Europe. Considerable evidence is brought in favour of the view that this octoploid species arose as a cross between two tetraploids, the hybrid being sterile but later producing a fertile form with twice as many chromosomes. It is found, for example, that ten species fall into the ivory-magenta-purple colour series, while four others are ivory-yellow-scarlet, while *D variabilis* alone has factors belonging to both series. The inheritance of the *Y* factor for yellow flavone is, moreover, tetrasomic, resulting from random assortment of four homologous chromosomes. In the reduction division, associations composed of two, four, six, and eight chromosomes can be seen, apparently resulting from the earlier conjugation of homologous chromosomes in synapsis. No more striking case could be found of the way in which correlated cytological and genetical investigations throw light on the origin and history of cultivated forms, and it is to be hoped that these researches will be carried further

**Bibliography of Genetics.**—There has recently appeared a work which should prove of considerable value to plant breeders and others interested in the subject This is the "Bibliographical Monograph on Plant Genetics, 1900–1925", by H Matsuura, published by the Tokyo Imperial University—a large octavo volume of 500 pages The greater part of the work gives a résumé of genetical researches under the heading of the various genera arranged in alphabetical order The geneticist has only to look up the genus, and he will at once find a succinct account of what has been already done, with full references to the original papers in the bibliography which forms the second part of the work There can be few students of the subject who have not frequently experienced the need of such a work, and they will be grateful to Mr. Matsuura for the immense labour that has gone into its compilation. It can be obtained in London from Messrs. Dulau and Co of Bond Street, for the moderate price of 10*s* 6*d*

**Non-Marine Mollusca of Oregon and Washington**—Unlike the marine, which have been closely studied, and the literature of which is obtainable in comparatively compact form, the non-marine mollusca of the States of Oregon and Washington have been relatively neglected and their literature dispersed in scattered papers This has now been remedied by the publication of a monograph by Junius Henderson (*Univ Colorado Studies*, vol 17, No 2) Considerable material for the purpose was obtained on expeditions sent out by the University of Colorado Museum, whilst the author himself visited personally 225 widely distributed localities in the two States The contents of other collections and past records have also been drawn upon As a result some 186 species are recorded and figured in text illustrations, every endeavour having been made to render the identifications and synonymy correct and to bring the nomenclature up-to-date. A useful index has been provided.

**Bibliography of Seismology.**—In the spring of 1926, the Eastern Section of the Seismological Society of America began the publication of a valuable bibliographical bulletin of works relating to earthquakes The bulletin was issued quarterly under the editorship of Mr E A Hodgson, and was distributed in a mimeographed form to the members of the Eastern Section as well as to various scientific journals. It was afterwards reprinted in the *Bulletin* of the Seismological Society It has now been decided to continue the previous lists in a new series entitled "Bibliography of Seismology", the first part of which (for Jan -Mar. 1929) appears under the same editorship as before in the *Publications* of the Dominion Observatory, Ottawa. It contains the titles (with an occasional brief abstract) of one hundred papers.

**Raman Effect.**—The amount of light that is scattered by a fluid without change in wave-length increases enormously when the substance is in the critical state Raman himself suggested that an analogous increase occurred with the modified secondary radiation from carbon dioxide, but W. H Martin afterwards obtained negative results with a mixture of phenol and water (see NATURE, Oct. 6, p. 506; 1928) The question is important, and has now again been attacked by S. L. Ziemecki and K. Narkiewicz-

Jodko, in Warsaw. Their work, which is outlined in *Die Naturwissenschaften* for Nov. 8, was done with the critical mixture of isobutyric acid and water at 24° C., with a powerful mercury arc of special construction for the primary source. The Raman lines due to the acid were found to be present in the scattered light, but their intensity was certainly not more than some 30 per cent above normal, and even this apparent increase may have been due to a heavy continuous background in the secondary spectrum. They point out that this furnishes an experimental proof that the Raman radiation is not coherent. Two further papers on the Raman effect have also appeared in recent issues of the *Indian Journal of Physics*, the third number of the current volume containing an account of an extended series of observations on modified radiation, by S. Venkateswaran and A. S. Ganesan, and the fourth number a useful summary and bibliography of 150 papers on the subject, by Dr. Ganesan.

**International Temperature Scales.**—The importance of having an international temperature scale for high temperatures is admitted by every chemist and physicist. The international temperature scale adopted in 1927 by the General Conference of Weights and Measures, representing thirty-one nations, is intended to reproduce, as closely as can be done with our present knowledge, the Centigrade thermodynamic temperature scale—the Kelvin scale. In this scale the temperatures of melting ice and of condensing water vapour, when both are under the pressure of one standard atmosphere, are numbered 0° and 100° respectively. This scale would be exactly realised with an ideal gas in a perfect gas thermometer. In practice it is closely realised by several of the permanent gases. The gas thermometer, however, is inconvenient for ordinary use. In practice, the results of the best gas thermometer determinations have been made permanently available by determining the freezing and boiling points of various pure metals up to the melting point of palladium, which is about 1550° C. These thermometric fixed points can be used in defining practical temperature scales with the help of convenient interpolation instruments. We learn from a paper on temperature scales by W. F. Roeser, published by the U.S. Bureau of Standards (*Research Paper*, No. 99), that the new scale (1927) is the fourth temperature scale used by the Bureau of Standards since 1912. His purpose was to determine how much change it was now necessary to make so that these scales could be compared with one another. The experimental results are highly satisfactory and show that the maximum difference in the temperature determined by the four scales is only a fraction of a degree Centigrade. The difference between the temperature of the freezing point of copper (1083°) and that of gold (1063°) is 20° C., with a maximum inaccuracy of less than the half of one per cent.

**The Calculation and Interpretation of Parachors.**—Some years ago S. Sugden showed that the product of the molecular volume by the fourth root of the surface tension of a liquid, called the *parachor*, might be expected to give a molecular volume at temperatures at which the liquids have the same surface tension. This was divided among the atoms of the compound, and the parachor of a compound could then be represented as the sum of the parachors of its atoms and certain constants characteristic of the types of linkages in the molecules. This has led to many interesting results from the point of view of the structure of compounds. In the September issue of the *Journal of the Chemical Society*, S. A. Mumford and J. W. C. Phillips show by an extensive survey of the data that, although the atomic constants of Sugden are probably very nearly correct, the change due to an increment of $CH_2$, and hence of carbon and hydrogen values, which they propose, leads to greater accuracy in the calculated parachors, especially in the case of compounds of high molecular weight. In their scheme also the parachor loses its strictly additive character and becomes definitely constitutive, stresses due to spatial arrangement of, and electrostatic influences between, atoms and groups in a molecule being accompanied by well-defined parachor variations. If these conclusions are substantiated, the value of the parachor method will be increased rather than diminished, since it will be able to throw still more light on the structure of compounds.

**Decomposition in a Crystal.**—Some very striking results have been obtained by Dr. J. Colvin and Mr. Hume in a study of the process of dehydration in crystals of potassium hydrogen oxalate hemihydrate, $2KHC_2O_4 \cdot H_2O$ (*Proceedings of the Royal Society*, November, p. 635). This substance forms transparent plates of somewhat indefinite form, and decomposition, when it occurs, usually starts at an edge, where it is first evidenced by the appearance of a black dot. The dot then increases in size, and grows as a black area bounded by lines which are parallel, in general, to edges of the crystal. The rate of advance of the black edge in any particular direction can be followed with ease by means of a travelling microscope, and is constant, but occasionally an edge will halt for a few minutes, and then start off again with the same speed as before. The steady rate of advance depends upon the direction in which the reaction is proceeding into the crystal, and varies considerably from one batch of plates to another, but has in all cases a large positive temperature coefficient, equivalent to a heat of activation in the neighbourhood of forty kilocalories.

**Bearings and Lubrication.**—The commonest component of machinery of all kinds is the journal revolving in a bearing, and the design, construction, lubrication, and maintenance of such bearings present many problems to the engineer. While such investigators as Beauchamp Tower, Osborne Reynolds, Sir John Dewrance, Summerfeld, Michell, and Kingsbury have done a great deal to advance the knowledge of the subject, there is much to be learnt regarding the size, lining, and clearances of bearings, and the properties and working conditions of the lubricants, to which attention was directed in an important paper on "Journal Bearing Practice", by Mr. F. Hodgkinson, read to the Institution of Mechanical Engineers on Nov. 15. The paper and a summary of the discussion which followed is given in both *Engineering* and the *Engineer* for Nov. 22. A few years ago, it was held that the relation which should govern the design of a high-speed bearing was that the pressure in pounds per sq. in., $P$, multiplied by the velocity of the rubbing surfaces in feet per second, $V$, should be 2500, but in modern practice, pressures run up to 150 pounds with velocities up to 150 feet. These figures are from steam turbines. It was also formerly considered that the bearing should be cool to the touch, but it was mentioned in the discussion that running the bearings of a certain 41,000 k.w. machine at 140° F. instead of 120° F. led to a saving of coal equal to £142 per annum. One interesting reference in this paper was that made to a gyroscopic stabiliser for a ship, the rotor of which weighed 230,000 lb. and ran at 800 r.p.m. The maximum bearing pressure in this case approximated to 900 lb. per sq. in. of projected surface.

## Anniversary Meeting of the Royal Society.

THE anniversary meeting of the Royal Society was held on Nov. 30, and the presidential address delivered by Sir Ernest Rutherford. He referred to the loss by death during the past year of fourteen fellows of the Society and one fellow elected under Statute 12, which provides for the admission of persons who have rendered conspicuous service to science, or whose election would be of signal benefit to the Society. Mention was also made of the retirement of Sir David Prain and Sir James Jeans, treasurer and secretary respectively for the past ten years, during which period the number of pages annually in the *Proceedings* has grown from 700 to 3661, an increase in publication effort due mainly to the activity of Sir James Jeans. Sir Henry Lyons succeeds Sir David Prain as treasurer, and Lord Rayleigh becomes foreign secretary in succession to the former Sir James Jeans is succeeded by Dr. F. E. Smith, well known for his work at the National Physical Laboratory on electrical standards, and until recently Director of the Scientific Research and Experiment Department at the Admiralty. He has recently been appointed Secretary to the Department of Scientific and Industrial Research, in connexion with which Sir Ernest remarked: "The Council feel that it is an advantage, rather than a disadvantage, that Dr. Smith should hold these two posts concurrently; for, although the main spheres of work of the two bodies are distinct, they have many interests in common in fostering the research activities of the nation".

The report of Council records a legacy, subject to a life interest, of £5000 free of duty, for general purposes, under the will of the late Prof. W. H. Perkin. A new research fellowship has been founded in accordance with the wishes of the late Mr. E. W. Smithson, who bequeathed to the Society a reversionary interest in the residue of his estate, now amounting to about £1200 a year. It has been decided to establish a fellowship at Cambridge for a period of four years in the first instance, and renewable annually up to a maximum of eight years in all, at an annual stipend of £800. The appointment is essentially for research, but permission will normally be given for the fellow to undertake a minimum of actual teaching in order to keep in touch with academic work. The award will usually be limited to British subjects.

Sir Ernest then discussed recent work in physics, referring in particular to the Raman effect and the constitution of hydrogen gas, and emphasising the close connexion between theory and experiment characteristic of modern progress; this appears elsewhere in this issue. The presentation of medals followed, and we print below extracts from the remarks made on the recipients' work.

### Presentation of Medals.

COPLEY MEDAL, AWARDED TO PROF. MAX PLANCK.

In the first instance, Planck applied the concept of the quantum of action to derive a formula giving quantitatively the distribution of energy in the spectrum of a complete radiator at any temperature, and it was basing upon this that Einstein developed a formula for the atomic heats of solids as a function of the temperature, which laid the foundation for all progress that has been made on this subject in the last twenty years. The concept of quanta of action as applied by Bohr to atomic processes in 1913 has proved of fundamental importance in elucidating the meaning of the complicated spectral series, and it has given an insight into the constitution of the atoms and been able to account for their various properties from first principles. In its most recent developments, Heisenberg has shown that Planck's quanta of action are bound up with an essential indeterminacy of physical measurements, which has the most far-reaching metaphysical consequences. Though his name is not immediately associated with any of these theories, Planck has taken an important part in formulating, clarifying, and criticising these developments of his original idea It is no exaggeration to say that the development of the idea of the quantum of action, first formulated by Planck nearly thirty years ago, has effected not only a veritable revolution in physics, but also profoundly changed our methods of thought and concepts of philosophy. Quite apart from his work on quanta, Planck's papers and books on other subjects are sufficient to place him in the front rank of physicists.

ROYAL MEDAL, AWARDED TO PROF. JOHN EDENSOR LITTLEWOOD.

The various problems which Prof. Littlewood has successfully attacked are characterised by their extreme difficulty. Into certain properties of primes, in which the Riemann zeta-function is employed, he has penetrated further than any other mathematician. Among the results he has obtained in this domain may be mentioned his proof that a conjectural expression given by Gauss for the number of primes less than a prescribed number is false, although its correctness is supported by all empirical evidence for numbers up to a thousand million. He has also obtained the best-known result giving the number of primes less than a prescribed number. In the general theory of series he has obtained various important results, the most celebrated of which is his Tauberian theorem for power-series. He has done much work on the general theory of functions, the earliest of which relates to integral functions of finite or zero order. His theorem that (roughly) a function of sufficiently low order has associated with it circles on which its minimum is of the same order as its maximum, has led the way to many developments by other mathematicians. Another striking piece of work is his extension to real sub-harmonic functions of the theorem due to Fatou, that an analytic function, bonded in the unit circle, tends to a limiting value almost everywhere on the unit circle. The importance and width of the results which have been published by the partnership of Prof. Hardy and Prof. Littlewood must also be referred to; among the subjects which they have treated are additive number theory, especially Waring and Goldbach problems, the theory of the zeta-function, Diophantine approximation, general theory of series, and Fourier's series.

ROYAL MEDAL, AWARDED TO PROF. ROBERT MUIR.

Prof. Muir is particularly distinguished for his pioneer work in the study of immunity reactions and mechanisms at a time when the foundations of the science of immunology were being laid, and the combining properties of normal and immune sera with antigen were being submitted to analysis by test-tube methods. Hæmolytic systems were chiefly studied and problems concerned with the specificity, constitution, and dissociation of immune bodies and with the combining properties of complements were attacked by accurate quantitative methods. These studies by Muir and his collaborators are of fundamental importance in the history of the development of the science. Muir's interests, however, have not

been confined to immunology. In the field of general and experimental pathology he has made important contributions to knowledge, and his researches on experimental anæmia produced by the injection of hæmolytic serum, and on the regenerative changes in the bone marrow in response to infection, are widely known.

DAVY MEDAL, AWARDED TO PROF. GILBERT NEWTON LEWIS

Prof. Lewis, of the University of California, is justly regarded as one of the leaders of modern physical chemistry, mainly on account of his remarkable contributions to chemical thermodynamics. He has been responsible for the development of fresh and original methods in attacking the problem of chemical affinity. By the skilful utilisation of appropriate experimental measurements, Lewis and his collaborators have shown how the free energy of a great variety of elements and compounds can be ascertained, and how this quantity is related to the thermal and electro-chemical characteristics of chemical reactions in which these elements and compounds are involved. It is to Lewis that we owe the concepts of 'activity' and 'activity coefficient', and recent advances, more especially in our knowledge of the thermodynamic properties of solutions, are the direct outcome of the introduction and development of these ideas. Further, in the closely related field of electrode potentials, his work, both on the theoretical and practical sides, has been outstanding. Lewis has rendered great service to chemistry by his theoretical work on electron configuration, and the bearing of this on polarity, valency, and cognate matters. His conceptions in this field and his recognition of the fundamental importance of the electron duplet have greatly influenced the development of modern chemical theory.

HUGHES MEDAL, AWARDED TO PROF. HANS GEIGER.

Prof. Geiger, of the University of Tubingen, has made many important contributions to our knowledge of radioactivity. He was the first to examine in detail the scattering of α-particles by matter. His classical investigation, in collaboration with E. Marsden, on the large angle scattering of α-particles in their passage through matter, not only gave a definite experimental foundation to the nuclear theory of the atom, but also led to the suggestion that the properties of an atom are defined by its atomic or ordinal number—a suggestion strikingly verified by the investigations of Moseley. Among many notable researches in radioactivity, special reference may be made to his determination of the ranges of the α-particles from all the radioactive elements with the greatest possible precision. From these measurements we are enabled to deduce the velocity of expulsion of the α-particle from many radioactive bodies. He discovered with Nuttall a remarkable relation between the life of a radioactive element and the velocity of the α-particle ejected from it. This relation, known as the Geiger-Nuttall law, has an intimate bearing on the new theories of the constitution of atomic nuclei. With Sir Ernest Rutherford, Geiger devised an electric method of counting α-particles and determined the number of α-particles emitted by a gram of radium. Later Geiger devised a point detector of great sensibility, which could be used for counting both α-particles and β-particles. Within the last few years he has succeeded in making a new type of detector, by which the liberation of any electron throughout a comparatively large volume is detected. This beautiful device, which has been applied by Geiger himself and by others to the study of the penetrating radiation in the atmosphere, promises to provide a method of great power for extending our knowledge of this radiation.

## Forestry in Kenya Colony.[1]

THE Annual Report of the Forest Department in Kenya Colony (to Dec. 31, 1928) directs attention to a fact which is well known in forestry economics, that any serious set-back to the country as a whole, whether due to climate, invasions of pests, disease or other troubles, will at once react on the forest sales and revenue. During the year here reviewed, the rains were everywhere much below the average, and a very serious infestation of locusts affected all parts of the country. The inevitable consequences followed, as stated in the report: "These two factors brought about a considerable restriction in trade and development of the Colony, which seriously affected the sales of timber and the partial drought greatly handicapped the Department's planting schemes". A check came to the continuous rise in revenue shown since 1926, as also in the rate of planting. This check is, however, regarded as purely temporary.

In the 1926 report the Conservator alluded to the fact that, owing to a paucity of staff, it was impossible to judge of the Colony's forest position as they had no data upon which to compare the annual cut with the existing stock of mature timber in the forests. The reviewer of that report in NATURE fully agreed with its author that such a position of affairs was "the most unsatisfactory aspect of the forestry position". In spite of the still existing difficulties due to an inadequate staff, the past two years have witnessed a decided effort to deal with the large amount of work connected with surveys of the forests and also, it is understood, with that important matter of stock mapping, however roughly, the growing stock of the reserves which are subject to fellings.

To the public outside Kenya, the most interesting factor connected with the forestry of the Colony is the well-known so-called pencil cedar (*Juniperus procera*), in which the report shows there was a large export, namely, 39,551 cub. ft., as compared with 13,548 cub. ft. in the previous year.

"The outlook of this trade", says the Conservator, "appears to be bright, provided only carefully selected, accurately sawn, and thoroughly seasoned slats are shipped and the price is moderate. A process has been developed in England for rapid treatment of the slats which appears to be most successful in seasoning and at the same time slightly softening the wood. The process appears to be a valuable one, which should help the trade considerably. Provided, however, the slats are carefully selected and thoroughly air seasoned, *i.e.* scientifically stacked under properly regulated conditions of air and moisture for, say, twelve months, the wood appears to be entirely suitable for pencil manufacture without artificial treatment.

"It is said that the preparatory treatment of cedar substitutes has made such improvement recently that these substitutes now compare very favourably in quality with cedar. It is not believed that these woods can ever be given quite the unique properties of cedar, but there is no doubt that cedar slats will have to be very carefully produced and at a comparatively low price if they are to compete successfully."

[1] Colony and Protectorate of Kenya. Forest Department Annual Report, 1928. Pp. 32. (Nairobi: Forest Department, 1929.)

It is a relief to know that the Conservator is of opinion that there are very considerable quantities of pencil cedar in the Colony, but that the survey of these is still very incomplete. The existing sawmills with cedar concessions can supply any immediate demands, and it is hoped in the near future to have other areas ready for exploitation.

Mr. H. M. Gardner, who is now the permanent Conservator, and his officers may be congratulated on a report which shows real progress. He is evidently an optimist, for the following extract shows that he has been able to perceive some benefit to forestry in the Colony as a result of the past drought. He writes: "The one satisfactory result of the drought conditions prevailing during the year was the very great increase in the public interest in forestry. The preservation of the existing forests and the increase of tree planting both on public and private land have become matters of public discussion throughout the Colony, which can result in nothing but good."

## Physics in Fuel Problems.

DR. C. H. LANDER, Director of Fuel Research, delivered one of the public lectures on physics in industry which are arranged by the Institute of Physics, on Nov. 27, taking as his subject "Physics in Relation to the Utilisation of Fuel". Apart from the great development of physical instruments for the control of fuel-using appliances, physics enters into the study of most problems of preparation, treatment, and utilisation of fuel.

The microscope has been effectively enlisted in the examination of coal, both for the study of thin sections by transmitted light, whereby the more resistant plant remains are made visible for identification, and for the investigation of polished surfaces by reflected light. X-ray photography as developed by Kemp has proved very useful in revealing the distribution, nature, and amount of ash in coal, information giving a ready guidance as to the prospects of 'washing' a coal to improve its worth. Again, by means of the X-ray spectrometer, graphite has been identified in cokes of different types, and it has been found possible to correlate the size of the graphite crystals with the reactivity of the cokes as determined by a chemical method used at the Fuel Research Station.

All processes of coal cleaning depend on utilising differences between the physical properties of the coal and the impurity to effect a separation. Difference in density, size, shape, friction, resiliency, and surface tension to water have all been used for this purpose. These applications were illustrated by description of the principles of the different methods of wet and dry cleaning.

Dr. Lander referred to the influence of the manner in which heat is applied on the process of carbonisation in retorts, and then turned to the physical principles of the utilisation of fuel. In order to reduce the size of the combustion chamber of furnaces fired by pulverised fuel, it has been considered advisable to create turbulence in the fire gases. Dr. Lander questioned whether uncontrolled turbulence will prove so satisfactory a solution as to obtain stable stream-line motion of air, and to induce the particles of fuel to move across the stream line in a controlled manner; this might perhaps be attained by giving a vertical motion to the air admitted at the perimeter of the chamber while the products are withdrawn axially. The fuel would be admitted at any convenient point or points, and the particles would be compelled to cross the stream lines in a stable manner.

The physics of the fuel fired furnace is complicated by the fact that it involves transfer of heat from moving gases. Unfortunately, the complications are such as to prevent the treatment of the problem by 'models', as in aerodynamical research. In such furnaces, in addition to the flow of combustion gases, heat interchange by conduction, forced and natural convection, and radiation are occurring. So complex are the conditions that reliance has usually to be placed on empirical formulæ of limited application, but progress is being made to place these on a more fundamental basis.

H. J. H.

## Undulant Fever in England and Wales.

UNDULANT fever was regarded thirty years ago as a sub-tropical disease almost confined to the Mediterranean coast-line and islands; hence the old name of Mediterranean or Malta fever applied to the disease. It has now been recognised in every continent, with the possible exception of Australia.

The causative micro-organism of undulant fever is a micrococcus (*M. melitensis*), first described by Bruce in 1886 (though some regard it as a bacillus), and is spread almost entirely by goats' milk. In 1897, Bang of Copenhagen described under the name *Bacillus abortus* a micro-organism causative of contagious abortion in cattle. Research during the last few years has directed attention to the close similarity between *M. melitensis* and *B. abortus*, and inasmuch as *B. abortus* is frequently present in cows' milk, the question has arisen whether this organism may not cause a form of undulant fever in man. As a result of close clinical and bacteriological study of cases of irregular fever occurring in Great Britain, on the Continent, and in America, it has been shown that man is occasionally infected with the contagious abortion organism with the production of a form of undulant fever.

An exhaustive report on the subject by Capt. Dalrymple-Champneys has been issued by the Ministry of Health ("Undulant Fever." *Reps. on Pub. Health and Med. Subjects*, No. 56. London: H.M. Stationery Office. 1*s*. 6*d*. net), and it is found that at least 14 authentic cases of undulant fever in man caused by the *abortus* variety of the organism have originated in England. Many cases have been described in Denmark, some in Germany, and a number in America (366 cases this year, according to a *Daily Science News Bull.* issued by Science Service, Washington, D.C.). Contagious abortion is also widespread among animals other than the cow, namely, the sheep, pig, goat, horse, and dog, the causative organisms being of the *abortus* type, but sometimes presenting minute differences, so that several varieties exist.

Dr. Forest Huddleson has published a valuable contribution on the differentiation of these varieties, or species as he prefers to call them (*Technical Bull.*, No. 100, 1929. Agricultural Experiment Station, Michigan State College). The organisms are placed in a genus *Brucella*, which is divided into three main species, namely, *Br. abortus* (Bang), *Br. suis* (Traum),

and *Br. melitensis* (Bruce), as they show distinct differences from one another Some 6·9 per cent of samples of English milk contain *Br. abortus*, yet undulant fever from this source is a rarity The explanation of this apparent anomaly may be that this organism is of low virulence for man. Thus, it is difficult to infect monkeys with *Br abortus*, whereas both *Br. melitensis* and *suis* are highly infective for this animal. The Americans are, therefore, disposed to attach more importance to the porcine than to the cattle strain of *Brucella* as a source of undulant fever in man derived from animals other than the goat.

## University and Educational Intelligence.

CAMBRIDGE.—The Vice-Chancellor has announced that he has appointed Prof. Hermann Weyl, professor of higher mathematics in the Technical High School, Zurich, to be lecturer on Mr. Rouse Ball's foundation for the present academical year.

EDINBURGH.—At the meeting of the University Court on Monday, Nov. 25, on the recommendation of the Senatus, Dr. J. E. Mackenzie, reader in chemistry, was appointed to membership of the Senatus, and Dr. C. H. O'Donoghue, lecturer in zoology, was appointed reader with a seat on the Faculty of Science.

MANCHESTER.—The following honorary research fellows have been appointed: Dr. W. L. Dubère (Louvain), in physiology; Mrs. Wright Baker (Manchester), in botany; Miss Isabel Cookson (Melbourne), in botany; Dr. Stephen Náray-Szabó (Budapest), in physics; Prof. Linus Pauling (Pasadena, California), in physics; Mr. Joseph West (Manchester), in physics.

Mr. Harold Walkden has been elected to a Research Studentship in Botany.

AT the annual meeting of the court of governors of the London School of Hygiene and Tropical Medicine, held on Nov. 27, the board of management of the School presented its fifth annual report. In the year under review, ended July 31, 1929, the new home of the School, its equipment, and the development of its organisation advanced steadily towards completion, and on July 18 the Prince of Wales formally opened the new building. Special reference is made in the report to the new course of study designed to prepare candidates for the examination for the diplomas in public health, and especially the new academic diploma instituted this year by the University of London. This course is planned in a broad, practical spirit, and gives promise of a great advance on anything which has hitherto been systematically attempted with regard to public health teaching. Two large centres of public health administration have been secured as demonstration areas, an advisory committee of experts of the first standing in the public health service appointed, and a scheme of special lectures arranged. The courses of study in tropical medicine and hygiene are maintained at a high level, and include a special short course in hygiene for business or professional men and women proceeding to the tropics. The University Grants Committee has intimated that the Treasury has sanctioned a recurrent grant-in-aid at the rate of £40,000 a year, but impresses upon the School the necessity for taking all possible steps to secure an increased private income from the Colonies, from public or private subscriptions, and in other ways.

## Calendar of Patent Records.

December 8, 1823.—The waterproofing industry dates from the patent granted to Charles Macintosh for his "process and manufacture whereby the texture of hemp, flax, wool, cotton, and silk, and also leather, paper, and other substances, may be rendered impervious to water and air", the specification of which was enrolled on Dec. 8, 1823 The process, which consisted in placing a sheet of rubber (formed by dissolving small pieces of rubber in naphtha and allowing the solvent to evaporate) between two layers of fabric, was very successful, and Macintosh's goods quickly attained a high reputation

December 9, 1815.—The original gas-meter of Samuel Clegg was patented on Dec 9, 1815. The apparatus consisted of a rotating wheel with a hollow rim connected by hollow arms with inlet and outlet passages for the gas in the axle, and provided with a water seal which closed the inlet and opened the outlet at the proper moment so that the number of revolutions of the wheel was a measure of the quantity of gas passing through. It was greatly improved later, but did not become commercially successful until towards the end of the patent term. The validity of the patent was established in the courts in an action for infringement.

December 10, 1779.—James Keir, F.R.S., doctor, soldier, manufacturer, and chemist, was granted a patent on Dec. 10, 1779, for "a compound metal capable of being forged, more fit for the making of bolts, nails, and sheathing for ships than any metal heretofore used for those purposes". The new alloy —which contained 54 per cent copper, 40·5 per cent zinc, and 5·5 per cent iron—was brought to the attention of the Admiralty by Mathew Boulton (who called himself the joint inventor), and a ship—the *Juno* frigate—was placed at Keir's disposal for a trial. The requisite number of plates and bolts were made, but there is no further record of the experiment. Keir's metal does not appear to have been referred to in the litigation on the Muntz metal patent sixty or so years later.

December 10, 1782.—The "new invented method of making small shot solid throughout and perfectly globular in form" by pouring the melted metal from a height into water was patented by William Watts, a plumber of Bristol, on Dec. 10, 1782. The process was adopted with success and was in general use by the end of the century.

December 10, 1845.—The first pneumatic tyre was patented by Robert William Thomson on Dec. 10, 1845, and consisted of a hollow belt composed of several thicknesses of canvas saturated with rubber solution and cemented together, the whole being then vulcanised. The cover was of leather. A set of the tyres is said to have run for 1200 miles without deterioration. Dunlop's patent, on which the present industry is based, was not granted until 43 years later.

December 11, 1863.—The ammonia-soda method of making sodium carbonate was made commercially successful by the process invented by Ernest Solvay and patented by him in Great Britain on Dec. 11, 1863. A factory was opened at Charleroi in 1865, and the industry quickly became established and finally ousted the Leblanc process. Brunner, Mond and Co., at their works at Northwick, were the first in England to adopt the new process.

December 12, 1885.—The incandescent gas mantle was patented in Great Britain by the late Karl Auer von Welsbach of Vienna, the inventor, on Dec. 12, 1885. The first mantle to reach England was brought over in a bird-cage by a woman, who refused to let the cage go out of her hands during the journey.

## Societies and Academies.

### LONDON

**Mineralogical Society,** Nov. 6.—**C. E. Tilley**: On scawtite, a new mineral from Scawt Hill, Co. Antrim (with chemical analysis by Mr. M. H. Hey). This new monoclinic mineral, with composition $6CaO.4SiO_2.3CO_2$, occurs in the contact zone between the chalk and tertiary dolerite, from which another new mineral, larnite, was recently described (*Min. Mag.*, vol. 22, p. 77).—**F. Coles Phillips**: On the composition-plane of [010]-twins in the acid plagioclases. In the true pericline twin, the inclination of the variable composition-plane for different composition is correctly given by Wulfing's curve. T. Barth's conclusion that there is no regular variation is not justifiable, and results partly from confusion with other twin-laws such as that of acline *A*. The pericline twin should be of frequent occurrence in the crystalline schists.—**M. H. Hey**: On the variation of optical properties with chemical composition in the rhodonite-bustamite series. A complete optical study of three analysed members of the rhodonite-bustamite series, with the data available from the literature, shows regular variation in the optical properties and specific gravity with change in lime content.—**F. Coles Phillips**: A preliminary account of some mineralogical and chemical changes induced by progressive metamorphism in the Green Bed group of the Scottish Dalradian. Analyses prove the Green Beds to be a truly isochemical series in respect of the constituents significant in progressive metamorphism. The earliest-formed plagioclase is pure albite, but a progressive entry of the anorthite molecule can be traced. The adjustment to equilibrium is apparently close, all the reconstituted plagioclase of a given rock having the same composition. In the highest grades the felspar is a medium andesine. Similar variations with increasing grade are found in the associated epidiorites. The earliest-formed greenish micaceous mineral is a true potash mica, which undergoes increase in FeO in higher grades. Hornblende appears in the chlorite-zone only in rocks low in potash.

**Optical Society,** Nov. 14.—**A. G. Frewin**: (1) The Busch optometer (eye refractor) designed by Prof. Thorner; (2) A glare-free, reflexless, stereoscopic hand ophthalmoscope. The new ophthalmoscope has a concave mirror which focuses a source of light on the lower part of the patient's dilated pupil. The optical system is such that the two pupils of the observer are conjugate with two separated points just above the image of the light. The action is thus similar to that of a policeman peering through a small window-pane into a dark room which he illuminates with his bull's-eye.

### PARIS.

**Academy of Sciences,** Oct. 28.—**A. Cotton**: The problem of asymmetric synthesis and the combined actions of polarised light and of a magnetic field on certain photographic plates.—**Georges Claude**: The first attempts to realise at Cuba a Claude-Boucherot apparatus. An account, with photographs, of the first unsuccessful attempt to launch a tube, 2 metres in diameter and 2 kilometres long, in the bay of Matanzas, Cuba.—**Pierre Weiss** and **R. Forrer**: The magnetisation to saturation of ferrocobalts and the atomic moments of iron and of cobalt. The magnetisation to saturation of 25 cobalt-iron alloys, ranging from 0 to 100 per cent cobalt, is described. The results are given graphically.—**J. Herbrand**: The limited solutions of certain functional equations.—**P. Dubreil**: Some complements to the theory of Nœther.—**J. A. Lappo-Danilevski**: The explicit expressions of the invariants of a monodromic group of a system of linear differential equations with arbitrary rational coefficients.—**N. André Roussel**: The generalised primitive of a function.—**Victor Vâlcovici**: The generalisation of the theorem of energy.—**Joseph Pérès**: Concerning the fundamental problem of the theory of vortices.—**William Loth**: Remarks on the guiding of ships or aeroplanes by directed waves.—**L. Décombe**: The mechanism of emission and Melde's experiment.—**Paul Jayles**: The electrolytic chlorination of benzene in methyl alcohol solution. Electrolysis without a diaphragm gave monochlorbenzene as the main product with a small proportion of benzene hexachloride. The same products were obtained in higher yields using a diaphragm.—**M. Laporte** and **La Goldstein**: Activation in the rare gases.—**A. Gillet** and **D. Gurchfeld**: The existence of a chemical equilibrium in autoxidation. In the direct oxidation by oxygen gas, in air, experiments are described in support of the view that there exists for each temperature an equilibrium pressure of oxygen below which no fixation of oxygen upon the autoxidisable body takes place.—**René Dubrisay** and **Albert Saint-Maxen**: The autoxidation of hydroquinone. Measurements giving the rate of oxidation of solutions of hydroquinone as a function of $pH$.—**Mme Ramart-Lucas** and **J. Hoch**: The comparative stability of the ethylenic stereoisomers and syntheses by ultra-violet rays.—**Gaston Rapin**: The action of some dioxides on very dilute aqueous solutions of potassium permanganate.—**L. Palfray** and **B. Rothstein**: The halogen derivatives of 1·4 cyclohexanediol (quinite). These can be obtained by the interaction of quinite and halogen acid.—**A. Pereira Forjas**: The spectrochemistry of Portuguese mineral waters. The water of Cambres. In addition to the ions detected by ordinary chemical methods, the spectroscope revealed the presence of radium, lead, uranium, vanadium, zinc, copper, germanium, and possibly thallium.—**Daniel Chalonge** and **F. W. Paul Götz**: Diurnal and nocturnal measurements of the quantity of ozone contained in the upper atmosphere. Measurements made at Paris and at Arosa by the spectrographic method, showed that at these places the presence or absence of the sun caused no notable change in the thickness of the ozone layer.—**A. Guillaume**: The alkaloid losses in the course of drying plants under varied conditions.—**Jules Amar**: The hemopneic coefficient and its applications.—**F. Obaton**: The relation between the nature of the glucides of *Sterigmatocystis nigra* and that of the sugars supplied to it. There is a correlation between the nature of the product made by the *Sterigmatocystis* and the sugar supplied as food to the mycelium. This relation is more marked between glucose and trehalose than between lævulose and mannitol.—**H. Pénau** and **G. Tanret**: The mercury reducing power of normal urine. The mercury reducing figure, although admittedly arbitrary, furnishes data which may be of service in the examination of urine.—**R. Fosse**, **A. Brunel**, and **P. de Græve**: Allantoinase and the origin of allantoic acid in plants.—**G. Ramon**: The production of a very active diphtheric toxin. The usual method of preparation is modified by the addition of a certain proportion of glucose. A toxin of high activity is obtained.

### ADELAIDE.

**Royal Society of South Australia,** Oct. 10.—**Thomas T. Colquhoun**: Polarity in *Casuarina paludosa*. Portions of bark of a young tree were removed, turned end for end and regrafted. The resultant shoots were tested for growth of roots unsuccessfully. The grafts

were removed and sectioned, the junction between the normal wood and inverted wood being marked by abnormal twisting of the tracheæ and tracheids, suggesting that translocation effects required the same orientation of the conducting strands.—**J. G. Woods**: Floristics and ecology of the mallee. The mallee is a transition region between the savannah forests of the southern wetter districts and the Eremian or northern communities of saltbush and mulga. The geographical range of the chief tree species (*Eucalyptus spp*) is sharply limited by the 20-inch isohyet in the south and the 8-inch isohyet in the north. In New South Wales its northern limit is determined by the northern limit of winter rains. The soils are all alkaline (pH about 8·0) and all contain nodular travertine limestone. Analysis of the growth forms gives a spectrum showing preponderance of woody shrubs and undershrubs of pronounced sclerophyll type and with a large therophytic element. Of the total number of species only about 25 per cent are confined to the mallee; the rest are migrants from the northern and southern communities.—**Albert H. Elston**: Australian Coleoptera (Part 6). Names and describes three new species of Elateridæ and one new genus and seven new species of Cleridæ.

### CAPE TOWN.

**Royal Society of South Africa**, Sept. 25.—**J. C. Vogel**: The cause of the Russell effect observed in oils. On exposing moist starch potassium iodide paper near oils of animal, vegetable, and mineral origin, iodine stains develop. The intensities of the stains produced by different oils are proportional to the intensities with which they act on photographic plates exposed near them (Russell effect). The reaction only takes place in the presence of oxygen. The liberation of iodine is due to the liberation of volatile oxidation products consisting of normal fatty acids containing four or more carbon atoms. The Russell effect and the supposed photoactivity of oils is due to the reducing properties of the vapours of these acids.—**H. Spencer Jones**: The secular variations of the orbital elements of the inner planets. Recent determinations of the change in the obliquity of the ecliptic indicate an appreciable correction to Newcomb's value, which can be accounted for by an error in his adopted mass of Venus. If the revised mass of Venus is adopted, the mass of the earth deduced from the secular variations of the orbital elements corresponds to a still smaller value of the solar parallax. The discordance can be traced to the motion of the node of Venus upon which the mass of the earth obtained from the secular variations almost entirely depends. With the most probable system of masses, the discordance between the observed and theoretical motions is six times the probable error. The motion of the node of Venus is the only remaining outstanding discordance between theory and observation in the planetary elements.—**B. de St. J. van der Riet** and **G. W. B. van der Lingen**: The wax of the rhenoster bush (*Elytropappus Rhenocerotes*). The air-dry tips of Rhenoster bush collected at Stellenbosch were found to yield on extraction with volatile organic solvents up to about 10 per cent of wax-like material. The yield and nature of the 'wax' varied according to the solvent used for extraction.—**F. C. Cawston**: The problem of the ventilation of iron roofs in the tropics. The present system of ventilating iron roofs is very inadequate and a cowl on the summit is insufficient unless there is a corresponding provision of air inlet. This inlet should be provided by means of a ventilating shaft inserted on a slant at each corner of the roof to supplement adventitious draughts.

### LENINGRAD.

**Academie des Sciences** (*Comptes rendus*, No. 16).—**W. Williams**: Action of nitric acid on dihydroperillamine. Cyclical primary amines of the terpene series with the $NH_2$ group in the side chain are able, like the polymethylene primary amines, under the influence of nitric acid, to isomerise with the increase in the cycle by one atom of carbon.—**V. Feofilaktov**: The condensation of pyruvic acid with formaldehyde in the presence of sulphuric acid. The usual idea, that the product of the condensation is a tetramethylene-1:3-dioxalic acid, namely, $C_8H_8O_6$, is erroneous; there are two products, and one of them, mistaken for $C_8H_8O_6$, has actually the formula $C_9H_8O_6$ and the structure of a methylene-bis-α-tetronic acid.—**B. Numerov** and **N. Samsonov**: Results of gravimetric observations made in 1928 near Lake Baskuntchak. A gravitational survey of the area revealed the presence of several anomalies which must depend on the geological strata, but the area surveyed was not sufficiently extensive.—**B. Numerov** and **B. Kozlovsky**: Results of gravimetric observations made in 1927–28 in the Emba area. Minimums of gravitational force in the area surveyed correspond to the places where more ancient strata, namely, Permotriassic, come near the surface, while the oil-bearing strata are somewhat removed from them. The greatest negative anomaly indicates the presence of salt-bearing strata.—**N. Nasonov**: Notes on *Phlebotomus* (3). A gradual increase in the numbers of sand-flies in the Crimea which has been observed during the last fifty years is due to the gradual progressive desiccation of the peninsula caused by the deforestation of the Yaila mountains.—**P. Schmidt**: The subfamily Blepsiinæ (Pisces, Cottidæ) in the Pacific. The following forms occur in the North Pacific: *Blepsias cirrhosus* Pall., *B. cirrhosus* sbsp. *draciscus* Jord. and Starks; *B. bilobus* C.V. (=*Histiocottus bilobus* C.V.); *Nautichthys oculofasciatus* Gir. (=*Nautiscus pribilovius* Jord. and Gilbert).

### PRAGUE.

**Czech (Bohemian) Academy of Sciences and Arts** (Second Class, Natural Sciences and Medicine), Oct. 18.—**Dr. Sedláčková**: Influence of choline on the glycoregulation of tissues.—**V. Vondráček**: Characterology from the medical viewpoint.—**A. Jílek** and **J. Lukas**: Electroanalytical determination of thallium as thallic oxide. The anodic deposit from solutions of thallous nitrate in presence of hydrofluoric acid and hydrogen peroxide consists practically of $Tl_2O_3 \cdot HF$; this may serve for quantitative estimation; in the presence of alkali salts the results are somewhat higher.—**K. Kavina**: Virescence of flowers of *Anthriscus cerefolium* Hoffm. subspec. *trichospermus* Schult.—**R. Šimůnek**: The resistance of electrolytes to high frequency oscillating currents. In an oscillating circuit the presence of electrolyte increases its high frequency resistance. It was measured at wavelengths of 600, 300, 150 metres and compared with the value calculated from J. J. Thomson's formula; the agreement was satisfactory. The method is electrodeless.—**K. Koutský**: The quadratic character of numbers and the generalisation of a certain Lagrange rule of the partition of quadratic residues.—**J. Rasch**: Influence of fatty acids on the maximum of current due to atmospheric oxygen in electrolysis with the dropping mercury cathode. The maximum is greatest when the ionic concentration is *ca.* $0 \cdot 5 \times 10^{-5}n$, as in solutions of strong electrolytes. Undissociated molecules have the greater effect in suppressing the maximum the higher the acid; anions of lower acids are indifferent like those of strong electrolytes; palmitate and stearate molecules and ions

have great suppressor activity, due to their abnormally great adsorbability. From the suppressor action a measure for the adsorbability of the acids in the mercury-solution interface is derived.—**Milovidov**: *Influence of radium rays on the chondriosome of vegetable cells.*—**K. Dusl**: *Mathieu functions.*—**E. Votoček and S. Malachta**: A new transition from sugars to the furane group. Transition of 5-ketorhamno-lactone into the methyl ester of the methoxymethyl-furane-carboxylic acid has been effected by methyl alcohol and hydrochloric acid.—**L. Borovanský-O. Hněvkovský**: Growth of the body and the progression of ossification in boys from birth up to nineteen years of age.

Nov. 8.—**O. Tomíček and A. Jánský**: Determination of halogenides in presence of sulphites. In solutions of the normal sulphites only the iodide can be exactly estimated; in the presence of bisulphites the bromide is also exactly determinable; in fairly acidic solutions all the three halides are determinable. —**O. Tomíček and A. Jánský**: The determination of iodides and bromides in chlorides. Traces of iodide can be estimated directly by silver even in solutions containing 1 mgm. I' per litre of a 10 per cent NaCl solution. Winkler's apparatus and method for the isolation of bromides from chlorides has been improved.—**A. Orlov**: Wavellite from Černovice near Tábor (in south Bohemia).—**B. Hostinsky**: The probability of phenomena joined into Marek's chains. —**K. Žlábek**: Dependence of the form of musculus digastricus mandibulæ of man and anthropoid apes on the mechanism of the jaw-bone joint.—**B. Hejda and A. Vančura**: Urogenetic coefficients in liver diseases.

SYDNEY.

**Royal Society of New South Wales**, Oct. 2.—**J. A. Cresswick and S. W. E. Parsons**: The testing of lead azide detonators. The ballistic pendulum was used so that a direct reading might be obtained of each shot fired. As a preliminary, charges of 10 grams each of standard non-gelatinous powders were fired, using alternatively the aluminium and copper type detonators. The same explosives were then desensitised with liquid paraffin, to determine the point at which one type of detonator would fire the charge whilst the other type failed. After a lapse of two months the mixtures were again tested, using aluminium detonators, and in each case complete detonation of the charge resulted, with same development of power as when previously made. The results prove that aluminium (lead azide) detonators, as at present imported into Australia, are slightly more efficient as initiating agents than the older copper (mercury fulminate) type of the same number.—**J. C. Earl**: The action of acids on diazoaminobenzene. Diazoaminobenzene, when acted upon by acids, yields, according to the conditions, aminoazobenzene or phenyl diazonium salts and aniline. The detection of an intermediate product is described, with experiments showing the profound effect of very small quantities of acids on diazoaminobenzene. The employment of carbon dioxide to liberate the nitrous acid required for the preparation of diazoaminobenzene is advised.

WASHINGTON, D.C.

**National Academy of Sciences** (*Proc.*, vol. 15, No. 9, Sept. 15).—**Elery R. Becker, J. A. Schulz, and M. A. Emmerson**: A comparative study of the digestion of proteins and carbohydrates in goats during infusoria-free and -infected periods. Infusorian infection gives no significant advantage.—**Benjamin Kropp**: The melanophore activator of the eye. An investigation by blood-transfusion methods of the hypothesis that the blood carries an activator. Extracts of eyes of dark-adapted *Rana clamitans* tadpoles injected into the abdominal cavity of light-adapted tadpoles induced melanophore expansion. Probable source of the activator is the retina.—**F. Simon and E. Vohsen**: Note on Mr. King's paper: "The crystal structure of strontium".—**Roscoe G. Dickinson and Robert T. Dillon**: The Raman spectrum of gypsum. Comparison of the spectrum with that of an aqueous solution of ammonium sulphate.—**Robert T. Dillon and Roscoe G. Dickinson**: Raman spectra from acetone. Results do not agree with those obtained by Williams and Hollaender.—**F. O. Rice and R. E. Vollrath**: The thermal decomposition of acetone in the gaseous state. Pure dry nitrogen saturated with acetone was passed at a known rate through a quartz tube in an electric furnace at 630° C. About 60 per cent of the acetone decomposed is recovered as ketene ($CH_2:CO$). This result is not in accord with investigations in which rate of change of pressure is measured.—**Donald Statler Villars**: The equilibrium constants of reactions involving hydroxyl.—**Linus Pauling**: On the crystal structure of the chlorides of certain bivalent elements. Using results published by Bruni and Ferrari from powder data, it is deduced that cadmium and other divalent chlorides have a structure in which each cation is surrounded by six chloride ions approximately at the corners of a regular octahedron, six edges of which are shared with other octahedra so as to form a layer.—**L. H. Adams and R. E. Gibson**: The elastic properties of certain basic rocks and of their constituent minerals. Compressibilities, at pressures between 2000 and 12,000 megabaryes (1 megabarye = about 1 atmosphere) were measured by submitting specimens to hydrostatic pressure in a steel cylinder and determining decrease in volume. For basic rocks, it seems that compressibility calculated from mineral content gives a limit to which that of rocks approaches at high pressure. The maximum velocity of longitudinal waves through such rocks at 15,000 megabaryes and 30° C. is 7·4 km. a second. Garnet and jadeite have low compressibilities, indicating that eclogites transmit such waves at greater velocities.—**A. Oppenheim**: The minima of indefinite quaternary quadratic forms.—**G. A. Miller**: On the number of cyclic subgroups of a group.—**Henry P. Thielman**: On new integral addition theorems for Bessel functions. —**George D. Snell**: Dwarf, a new Mendelian recessive character of the house mouse. Mature individuals are about one-quarter the size of normal adults, are fairly healthy though subnormally active, and apparently sterile.—**Sophia Satina and A. F. Blakeslee**: Criteria of male and female in bread moulds (*Mucors*). There is no constant vegetative difference between gametangia of diœcious species, and an attempt to differentiate between them by imperfect sexual reactions failed.—**H. W. Leavitt, J. W. Gowen, and L. C. Jeness**: (1) Influence of aluminium on mortar strength. As aluminium content of sand increases from 0·25 per cent to 3·75 per cent, the tensile strength of mortar increases by more than 100 pounds; compression strength is not affected. (2) On the joint influence of iron and aluminium in native sands on mortar strength. The total correlation coefficient is +0·538. An equation is deduced: Mortar strength = 20 aluminium (per cent) + 48 iron (per cent) + 272. There must be chemical interaction between sand and cement.—**Roy J. Kennedy**: Planetary motion in a retarded Newtonian potential field. The idea corresponding to that of effective charge developed by Lienard and Wiechert in electro-magnetism is applied to gravitation.—**J. H. Van Vleck**: On the vibrational selection principles in the Raman effect.

## Official Publications Received.

BRITISH.

Proceedings of the Cambridge Philosophical Society. Vol 25, Part 4 Pp. 369-510. (Cambridge: At the University Press) 7s 6d net

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell Vol 67, No 395, November Pp 1289-1336+xxxviii (London: E. and F. N. Spon, Ltd.) 10s 6d

Ministry of Health. Treatment of Tuberculosis Costs at Residential Institutions (Memo. 122 C/T.) Pp 21 (London, Ministry of Health )

Tanganyika Territory. Tsetse Research Annual Report for the Year ended 31st March 1929. Pp 18. 2s. 6d Tsetse Reclamation Annual Report for the Year ended 31st March 1929 Pp. 10 1s. 6d (Dar es Salaam Government Printer )

Department of Agriculture, Ceylon Bulletin No. 86. The Control of "Calotermes" in Living Plants. By F. P Jepson Pp 11 40 cents Leaflet No. 57. Green Manuring with particular reference to Coconuts Pp. 10 5 cents. (Peradeniya )

FOREIGN.

*Department of the Interior*, U.S. Geological Survey Bulletin 799 Geology of the McCalls Ferry-Quarryville District, Pennsylvania By Eleanora Bliss Knopf and Anna I Jonas. Pp xiii+156+8 plates 35 cents Bulletin 808 Geology of the De Queen and Caddo Gap Quadrangles, Arkansas. By Hugh D Miser and A H. Purdue Pp. xi+195+18 plates. 75 cents. *Bulletin 809 Formulas and Tables for the Construction of Polyconic Projections* Compiled by C H. Birdseye Pp v+126 25 cents Bulletin 810-C: The Mount Spurr Region, Alaska By Stephen R Capps (Mineral Resources of Alaska, 1927-C) Pp. ii+141-172+plates 3-4. Bulletin 811-B Recent Mining Developments in the Creede District, Colorado By Esper S. Larsen. (Contributions to Economic Geology, 1929, Part 1) Pp. ii+89-112+plate 20 10 cents. (Washington, D C., Government Printing Office )

Department of the Interior: U S. Geological Survey Water Supply Paper 599: Ground Water in Yellowstone and Treasure Counties, Montana By George M. Hall and C S. Howard. Pp vi+118+7 plates 25 cents. Water-Supply Paper 600. Geology and Ground-Water Resources of Central and Southern Rosebud County, Montana. By B Coleman Renick, with Chemical Analyses of the Waters, by H. B Riffenburg. Pp. x+140+12 plates. (Washington, D.C. Government Printing Office) 35 cents.

CATALOGUES.

The Nickel Bulletin. Vol 2, No. 5, November. Pp 129-176. (London The Mond Nickel Co., Ltd )

Books Beautiful. Pp 32. (London: George G. Harrap and Co., Ltd.)

Annotated and Classified Catalogue of Works on Mathematics, Astronomy *and Physics, with an Appendix of Rare and Valuable Books, including the* Newton Library. (No. 816 ) Pp. 100. (London: Henry Sotheran, Ltd.)

## Diary of Societies.

*FRIDAY*, DECEMBER 6.

INSTITUTION OF WATER ENGINEERS (at Institution of Civil Engineers), at 10.30 A.M.—R C S. Walters: The Hydro-geology of the Chalk of England.—Prof E. Morton: Some Problems in Hydro geology.—Discussions on Reports of the Advisory Committee on Water of the Ministry of Health; Second Report of the Legislation Sub-Committee; Report on Rural Water Supplies; Draft Report of a Sub Committee of the Council on Stream Flow and Underground Water Records.

ROYAL SOCIETY OF MEDICINE (Otology Section), at 10.30 A M.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 5.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (at Liverpool University), at 6.—J. P. Davidson: The Manufacture of Tobacco.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Newcastle upon-Tyne), at 6.—Prof. Dempster Smith: Cutting Capabilities of Lathe Tools.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (jointly with Manchester Section of Institution of Rubber Industry) (at Engineers' Club, Manchester), at 7.—H C. Young: The Common Factors of Technical and Works Controls in the Rubber and Chemical Industries.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—Dr C. V. *Drysdale: Alternating-Current Potentiometers and* their Applications.

INSTITUTION OF LOCOMOTIVE ENGINEERS, LONDON (at Manchester Literary and Philosophical Society, Manchester), at 7.—J. W. C. Armstrong: Pulverised Fuel Locomotives.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—W. A. Tookey and others: Diesel Engine Developments.

BRITISH NON-FERROUS RESEARCH ASSOCIATION (at Chamber of Commerce, Birmingham), at 7.—D. M. Smith: Spectroscopic Analysis of Metals.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. Bairstow and others: Discussion on How can the Pictorial Group best help the would-be Pictorialist?

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—A. B. Gowring: The Demolition of Lambeth Bridge.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—J. A. Steers: The Great Barrier Reefs and the Queensland Coast: a Geographical Reconnaissance (Lecture).

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Discussion on Anæsthesia in Rectal Surgery.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Hugh Walpole: The Novel and the Creative Spirit.

*SATURDAY*, DECEMBER 7.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Western District) (at Exeter), at 3.—Lieut Col F J Mead The Local Government Act, 1929

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W C 1) at 3.—W. H Spreadbury Some Birds of London's Commons

MINING INSTITUTE OF SCOTLAND (at Royal Technical College, Glasgow), at 3.—R. A. Peach: The Lochaber Water Power Scheme and its Geological Aspect.—Discussions on S Mavor's paper on Recent Progress in Underground Conveying and J L. Lambie's paper on Some Notes on Colliery Blasting Practice

*MONDAY*, DECEMBER 9

INSTITUTION OF ELECTRICAL ENGINEERS (North Eastern Centre) (at Armstrong College, Newcastle upon-Tyne), at 7.—B A G Churcher and A J King The Analysis and Measurement of the Noise emitted by Machinery

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—W. R. Rawlings and T C Gilbert Discussion on To Earth and not to Earth.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—Lt Col S E Monkhouse and L C Grant The Heating of Buildings Electrically by means of Thermal Storage.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Associate Members' and Graduates' Section) (at Borough Polytechnic), at 7.—B A Pountney Common and Uncommon Boiler Troubles

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—Prof. W. L. Bragg X ray Optics (Lecture).

BRADFORD TEXTILE SOCIETY (at Midland Hotel, Bradford), at 7.30.—Dr S G. Barker Production of the Ideal Textile Fabric

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—G L Cassidy Melting Furnaces

SURVEYORS' INSTITUTION, at 8.—W E A. *Hall: The Landlord and Tenant* Act 1927 in Operation

TWICKENHAM LITERARY AND SCIENTIFIC SOCIETY (at Free Library, Twickenham), at 8.—C A. Wood Birds of Middlesex.

MEDICAL SOCIETY OF LONDON, at 8.30.—W Trotter and others: Discussion on The Treatment of Head Injuries

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at Gloucester).

ROYAL IRISH ACADEMY (Dublin).

*TUESDAY*, DECEMBER 10.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Section), at 5.—Dr J W Trevan, Dr T Izod Bennett, Dr. D. T. Davies, Dr. L E H Whitby, and others: Phenylhydrazine in the Treatment of Polycythæmia.—Dr. R. Schlesinger, Dr. F J Poynton, and others: Nirvanol in the Treatment of Chorea

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—J. Gillespie: The Engineer in Relation to the Petroleum Industry.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—Vice-Admiral Sir Robert Dixon: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—Lt. Col S. E. Monkhouse and L C. Grant: The Heating of Buildings Electrically by means of Thermal Storage.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—Dr. G. C. Simpson: Lightning (Kelvin Lecture).

ILLUMINATING ENGINEERING SOCIETY (at Home Office Industrial Museum), at 7.—Discussion on Problems in Illuminating Engineering, opened by a series of short contributions on different subjects, including The Lighting of Large Vertical Surfaces, A. Cunnington, The Lighting of Operating Tables in Hospitals, E. Stroud; A Large Gas-Lighted Sign Outside Watson House, F. C. Smith, The Lighting of the Savoy Theatre and Hotel, Prof. H. Robertson and B. Ionides.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group), at 7.—Helen Messinger Murdoch: The World in its True Colours.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at King's Head Hotel, Coventry), at 7.30.—Dr. B. P. Haigh: The Relative *Safety of Mild and High-Tensile Steels under Alternating and Pulsating Stresses.*

ELECTRICAL POWER ENGINEERS' ASSOCIATION (Edinburgh Section) (at North British Station Hotel, Edinburgh), at 7.30.—R. H. Rawll: The Electrical Equipment of Factories (Lecture).

INSTITUTE OF METALS (North-East Coast Local Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—W. T. Griffiths: Nickel in Non-ferrous Foundry Alloys.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—T. A. Joyce and E. L. Gruning: The Expedition of the British Museum to British Honduras, 1929.

ROYAL SOCIETY OF MEDICINE (Psychiatry and Disease in Children Sections), at 8.30.—Discussion on The Difficult Child

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, at 8.30.—Dr. S. S. Pickles: Rubber Manufacture (Lecture).

WEST KENT SCIENTIFIC SOCIETY (at Wesleyan Hall, Blackheath Village), at 8.30.

*WEDNESDAY*, DECEMBER 11.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology), at 5.30.—C. Rowntree and others: Discussion on Complications of Operations for Piles.

INSTITUTION OF CIVIL ENGINEERS (Informal Meeting), at 6.—A. H. Barker: The Heating of Buildings by Electricity off Supply Mains, with Special Reference to the Problem of Heat-Storage and Off-Peak Loads.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Northern Ireland District) (at Municipal College of Technology, Belfast), at 6.45.—R. B. Donald: Town Planning.

SOCIETY OF CHEMICAL INDUSTRY (Newcastle-upon-Tyne Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.—L. H. Sensicle: Fuel Gas Technique—Some Modern Developments.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (jointly with Society of Chemical Industry, Edinburgh and East of Scotland Section) (at North British Station Hotel, Edinburgh), at 7.30.—J. A. Watson: The Industrial Minerals of Scotland.

ROYAL SOCIETY OF ARTS, at 8.—Major C. Wheeler: Overheads and other Factors influencing Road Transport Costs, from an Engineer's View-point.

FARADAY SOCIETY (jointly with the Electroplaters' and Depositors' Technical Society) (at Northampton Polytechnic Institute), at 8.—B. Clark and E. O. Jones: The Effect of Addition Agents upon the Conductivity, Cathodic Polarisation, and Grain Size of Deposits obtained from the Cell $Cu/CuSO_4$, $H_2SO_4/Cu$.—S. Glasstone and E. B. Sanigar: The Electro-Deposition of Silver from Argento-cyanide Solutions.

*THURSDAY*, DECEMBER 12.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—W. N. Bailey: *An Extension of Whipple's Theorem on Well-poised Hypergeometric Series*.—Miss M. L. Cartwright: On the Maximum Modulus Principle for Functions with Zeros and Poles.—T. Estermann: On the Representation of a Number as the Sum of Two Products (Second Paper).—D. E. Littlewood: The Solution of Linear Congruences in Quaternions.—Prof. L. J. Mordell: On Hecke's Modular Functions and Some Other Analytic Functions in the Theory of Numbers.—L. Roth: Line Congruences in Three Dimensions.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 5.30.—Prof. H. Freundlich: Surface Forces and Chemical Equilibria (Liversidge Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (jointly with British Section of Société des Ingénieurs Civils de France), at 6.—L. A. F. Sokutowicz and A. Evain: The Electrical Plant and Network of the Société Électrique de la Sidérurgie Lorraine.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Dr. W. Rosenhain: The Development of Materials for Aircraft Purposes.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (jointly with Chemical Engineering Group) (at *Bristol University*), at 6.30.—S. Robson: The Treatment of Flotation Concentrates preparatory to Zinc Smelting.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—J. R. Douglas: What is expected of a Junior Engineer on joining his First Ship?

INSTITUTE OF METALS (Birmingham Local Section) (at Chamber of Commerce, Birmingham), at 7.—A. H. Mundey: Die Casting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Colour Group: Informal Meeting), at 7.

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates) (at Watergate House), at 7.15.—C. A. Partridge: Repairs.

INSTITUTION OF AUTOMOBILE ENGINEERS (jointly with Institution of the Rubber Industry) (at Grand Hotel, Birmingham), at 7.30.—A. Healey: The Mechanical Properties of Rubber.

INSTITUTION OF ELECTRICAL ENGINEERS (Dundee Sub-Centre) (at University College, Dundee), at 7.30.—A. F. Stevenson: Cable Design.

*INSTITUTE OF METALS (London Local Section) (jointly with Institute of* British Foundrymen) (at 83 Pall Mall), at 7.30.—D. F. Campbell and W. S. Gifford: Metal Melting by Electricity.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Tees-side Branch), at 7.30.—N. J. Inman: Modern Constructional Steelwork.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—J. Guild: The Insensitivity and Personal Equation Errors of Optical Settings.—*Exhibits and Demonstrations*:—Adam Hilger, Ltd.: Cylindrical Mirror corrected to give Freedom from Aberration in the Formation of an Image of a Distant Line when the Angle of Incidence is 45°.—C. Brown: Duo Chrome Sight Test.—C. W. Dixey and Son: The Maddox Cheiroscope.

INSTITUTION OF WELDING ENGINEERS (at Caxton Hall), at 7.45.—L. W. Schuster: The Fusion Welding of Unfired Pressure Vessels (Lecture).

INSTITUTE OF PATENTEES (at Caxton Hall), at 8.—Sir William A. Lane, *Bart.*: *Inventions as an Aid to Health.*

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.15.—Prof. Warrington Yorke: Blackwater Fever.

*FRIDAY*, DECEMBER 13.

BIOCHEMICAL SOCIETY (at St. Bartholomew's Hospital), at 3 P.M.—H. E. Archer and G. A. Harrison: The Effect of Reaction on the Heat Test *for Bence-Jones' Proteinuria*.—*W. H. Hurtley*: *Notes on the Determination of Iodine in Blood, etc.*—K. V. Thimann: The Precipitation of the Basic Amino-acids of Proteins by Phosphotungstic Acid.—M. J. Rowlands and B. Wilkinson: Vitamin Content of Grass Seeds in *Relationship to Manures*.—*A. G. Norman*: *The Biological Decomposition of Plant Materials*.—D. R. P. Murray and C. G. King: The Stereochemical Specificity of Esterases.—H. Chick and M. H. Roscoe: Stability to Heat of Vitamin $B_2$ (Anti-dermatitis, Anti-pellagra).—F. K. Herbert and M. C. Bourne: The Non-Glucose Reducing Substances of Blood, with Special Reference to Glutathione.—B. W. Town: Isolation of Isoleucine from Gliadin.—H. G. Reeves and F. T. Renborn: Some Properties of Dihydroxyacetone.—J. M. Gulland and R. A. Peters: Observations on the Reducing Substances in Avian Blood.—G. Graham: The Presence of Homogentisic Acid in the Blood of Patients with Alkaptonuria.

*ROYAL ASTRONOMICAL SOCIETY*, at 5.—*A. N. Brown*: *Observations of* (Ch 678) U Persei, 1924-29.—E. A. Kreiken: The Distribution of the Double Stars along the Giant Series.—J. G. Hagen: On the Significance of Baxendell's Nebulosity.—H. G. Tomkins: Three Features of the Lunar Crust, from Photographs taken at Dedham.—Dr. H. Spencer Jones and J. W. Jackson: Stellar Parallaxes Determined Photographically at the Cape Observatory (2nd list).—W. S. Franks: Visual Observations of Dark Nebulæ.

PHYSICAL SOCIETY (at Imperial College of Science and Technology), at 5.—J. H. Awbery and Dr. Ezer Griffiths: Apparatus for Determining the Specific Heat of a Material in Powder Form.—Dr. W. E. Deming: On the Determination of the Parameters in an Empirical Formula.—N. S. Alexander: The J-Phenomenon in X-Rays.

MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Prof. G. F. Charnock: Bearings for Power Shafting.

TEXTILE INSTITUTE (London Section) (at Chemical Society), at 6.45.—A. E. Woodhead: Commercial Application of the New Esterified Cotton Fibres.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.—*Dr. Stern*: *Fastness to Light*.—*C. D. O.* Winslade: Some Aspects of Colour Testing.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Informal Meeting) (at Newcastle-upon-Tyne), at 7.15.—E. Wilson and others: Is Sea Experience essential in order to become a Good Marine Engineer?

JUNIOR INSTITUTION OF ENGINEERS (at Royal Society of Arts), at 7.30.—Sir Ernest W. Moir, Bart.: Some Engineering Difficulties and how they were overcome (Presidential Address).

LEICESTER TEXTILE SOCIETY (at Victoria Hall, Leicester), at 7.30.—E. J. Spurr: The Dyeing and Finishing of Hosiery Fabrics.

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—Prof. F. C. Lea: Physical Testing.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND, at 8.—Dr. L. H. Lampitt: The Chemist and Commerce (S. M. Gluckstein Memorial Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Miss D. A. E. Garrod: Cave Excavation in the Near East.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at St. Thomas Café, Swansea).—E. A. Tyler: Pure Chemicals.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (jointly with Manchester Literary and Philosophical Society, Chemical Section) (at Manchester).—C. Hollins: Patent Law in Relation to the Dyestuffs Industry.

*SATURDAY*, DECEMBER 14.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Newcastle upon Tyne), at 2.30.

PHYSIOLOGICAL SOCIETY (at St. Thomas's Hospital).

## PUBLIC LECTURES.

*SATURDAY*, DECEMBER 7.

MATHEMATICAL ASSOCIATION (London Branch) (at Bedford College), at 3.—Prof. H. Levy: Dimensional Theory as a School Subject (Presidential Address).

HORNIMAN MUSEUM (*Forest Hill*), at 3.30.—*M. A. Phillips*: *British Wild Life off the Beaten Tracks.*

*MONDAY*, DECEMBER 9.

LONDON SCHOOL OF ECONOMICS, at 4.30.—E. H. Warmington: The Debt of Mediæval Explorers to Ancient Discoverers (4): Asia.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (Royal College of Science), at 5.30.—Dr. D. A. Allan: Rocks as Records of Earth History (Swiney Lectures). (Succeeding Lectures on Dec. 11, 13, 16, 18, 20, Jan. 20, 22, 24, 27, 29, 31.)

*TUESDAY*, DECEMBER 10.

TECHNICAL COLLEGE, CARDIFF, at 7.30.—Dr. J. H. Quastel: The Search for Drugs to cure Disease.

UNIVERSITY OF LEEDS, at 8.—*Dr. J. S. Anderson*: *Infection.*

*WEDNESDAY*, DECEMBER 11.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Prof. Winifred Cullis: Speed as a Psycho-Physiological Factor in the Life of To-day.

ROYAL ANTHROPOLOGICAL INSTITUTE (at Portland Hall, Great Portland Street Extension of Regent Street Polytechnic), at 5.30.—Prof. F. G. Parsons: The Anthropological History of the Modern Englishman.

*SATURDAY*, DECEMBER 14.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Witchcraft.

## EXHIBITION, ETC.

DECEMBER 6.

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY (at Central Hall, Westminster).

10.30 A.M. to 12.30 P.M.—W. E. Schall: A Single Valve Plant for Diagnosis and Deep Therapy.—Cuthbert Andrews: A Mobile X-ray Unit.—Dr. Ffrangcon Roberts: Modern Radiological Developments in Germany with Special Reference to the New Institute at Frankfurt.—Dr. A. Orliansky: Output of Transformers under Different Methods of High Tension Rectification.—W. R. Gray: A Hot Cathode Tube with Rotating Anode.—Dr. E. J. H. Roth: The Mekapion, an Ionisation Apparatus for the Absolute Measurement of X-ray Dose.

At 2.30.—Miss S. F. Cox and F. G. Spear: Tissue Culture and its Application to Radiological Problems.—Miss S. F. Cox: The Action of X-rays on Living Cells Cultivated *in vitro*.—Dr. F. G. Spear: The Immediate and Delayed Effects of Radium on Tissues Cultivated *in vitro*.

## CONFERENCE.

DECEMBER 6.

INSTITUTION OF CHEMICAL ENGINEERS (at Chemical Society).—Vapour Absorption and Adsorption.

At 10.30 A.M.—A. Hoch: The Recovery of Volatile Solvents (Brégeat Process).—J. S. Morgan: The Continuous Fractionation of Gases by Adsorbents.

At 2.30.—G. W. Himus: Evaporation of Water in Open Pans.—K. Evans and H. F. Pearson: The Industrial Application of Active Carbon.

SATURDAY, DECEMBER 14, 1929

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## The Museums Report and National Folk Museums

IN the concluding paragraphs of Part 1 of the Final Report of the Royal Commission on National Museums and Collections[1] our outstanding needs in the national museum service are indicated. In the order named there are an ethnographical museum, a folk museum, an Oriental museum, and a museum of casts. This sequence is not without its significance.

While it may be admitted without question that the Commissioners in giving first place to the need of an ethnographical museum have emphasised an almost astounding neglect of opportunity and, what is more, of a duty in an imperial system such as that of Great Britain, they are equally justified in regarding the institution of a folk museum as coming second in importance on the ground of urgency. If it is desirable that a record should be preserved of the daily life of the people in the past —a matter about which there can scarcely be two opinions when once its full significance has been grasped—it is necessary that steps should be taken to give effect to the proposal as soon as possible. Indeed, it is no exaggeration to say that in all probability there is no question upon which the Report of the Commission has touched which calls more insistently for immediate action. Almost day by day it will become more difficult to bring together the material from which such a museum must be formed. The action of the Royal Society of Arts has stimulated public opinion to an interest in the preservation of typical or striking examples of domestic architecture of the humbler sort belonging to the past. But these efforts are limited by a variety of conditions and they are confined to one class of material only. Peasant industries carried on in the cottages and villages of the remoter districts, such as the lace making and wood turning of Buckinghamshire, even if artificially stimulated as some have been, are unlikely to survive for very long; articles of obsolescent use will be thrown aside for modern substitutes; and those which have been discarded but preserved by a generation which once used them will be cast out as rubbish when that generation dies out. Recent experience has shown that it is becoming increasingly difficult to find examples of objects which a few years ago were comparatively common in the countryside.

In making its recommendation the Commission

[1] Royal Commission on National Museums and Galleries. Final Report. Part 1: General Conclusions and Recommendations, dated 20 September 1929. (Cmd. 3401.) Pp. 93. (London: H.M. Stationery Office, 1929.) 2s. net.

has very precisely in mind the type of museum which it would wish to see established Not only is a museum illustrating the domestic life of the people in the past contemplated, it is also recommended that this should be of the type known as the open-air museum. The report refers to the museums of this kind which have been instituted in Scandinavia and in Holland These museums, as is well known, consist of a number of typical dwellings of different periods which have been set up in a park, each fitted with the appropriate furniture, utensils, domestic appliances, and objects of peasant art of the period of the dwellings in which they are housed At present there is nothing of this kind in existence in Britain, and it is recommended that ultimately there should be one each for England, Scotland, Wales, and Ireland, but it is stressed that for the moment the case of England is the most urgent. Herein the Commission does not go beyond the warrant of the facts Conditions in Scotland, Wales, and Ireland are, and perhaps for some little time will continue to be, more favourable to the preservation of their distinctive peasant culture than they are in England, where local peculiarities are rapidly disappearing before modernising influences, and the population itself is rapidly losing the conservatism which still remains a characteristic of the people in the remoter parts of the rest of Britain

The Report contemplates a museum which will illustrate the domestic life of the past, but it is clear that such a museum of the folk is capable of an almost indefinite expansion in regard to time, local character, and the nature of the exhibits. To take the last point first. The Commissioners would appear to have had something of the nature of this question in mind when they refer to the advantages of the situation of the open-air museum at Stockholm near the famous 'Northern Museum' which contains "an enormous collection of objects illustrating the history and development of the Swedish people". Now, as it is not probable that our museum will have a similar advantage, this suggests the question: Up to what point can the function of a folk museum be understood to be to illustrate the culture of the people as a whole, or, in other words, where in the social scale must the line of demarcation of 'the folk' be drawn? Does there not come a stage in the time series at which the collections run the risk of being merely of antiquarian interest and of losing much of their educational value as an index of culture if a hard-and-fast line separating the grades of society be laid down? As an example of a practical question that arises, the authorities of the National Museum at Cardiff have included in their folk museum galleries, costumes of the upper classes of the eighteenth century Their local origin may be held to justify their inclusion there. In a national folk museum in England, their late date alone would determine their exclusion as other collections are available to receive them. Yet when it becomes necessary to adjudicate upon exhibits of an earlier date, which are less generally familiar, provided they are significant of the general level of culture and not of highly specialised character — military, ceremonial, or sumptuary — decision will become increasingly difficult

An analogous question may arise in connexion with the selection of the buildings it is desired to re-erect to form the museum Cottages, barns, and the like offer no difficulty, but the church and the manor house were equally an integral part of the life of the countryside, even if not intended for the occupation or sole use of the peasantry. Village crosses, boundary marks, milestones, and the like objects may also, it may be taken, come within the scope of our folk museum

As regards exhibits distinctively local in character, it may be thought that it is evidently the function of the local museum in the first instance to ensure their preservation On the other hand, it would be difficult to over-estimate the value to the anthropologist, the historian, and the geographer, of the inclusion of localised series exemplifying, for example, the culture of the Cotswolds, or of the Sussex area with its iron industry of uninterrupted pedigree, extending back to the early days of the working of that metal in England.

In the time series, it may perhaps be found equally difficult to draw the line of demarcation. The end of the Roman occupation affords a convenient starting-point. Yet settled life in Britain does not begin at that date, and if an attempt were made to complete the picture by reconstruction of dwellings and village sites for which there is evidence, there is no logical ground why a further step should not be taken and a lake-village or a hill-fort site, or even mounds and barrows, should not be reproduced

It may seem that a consideration of these points at this juncture is irrelevant to the recommendation of the Report, which goes no further than to recommend the institution of an open-air museum illustrating the *domestic* life of the people in the past. But the Report has made no attempt to define the scope of such a museum, and it is as well to keep in mind the difficulty of avoiding the expansion of the museum into something much wider than merely

peasant art and industry, cottage utensils, appliances and ornaments, in their appropriate setting of time and space Both from the educational and the scientific point of view, a museum of the history of our national culture of which the open-air museum formed a part would be the ideal At present, however, if only on practical grounds and as emphasising the immediate and pressing need, a more restricted conception of the aims of a folk museum must be regarded as holding the field.

One reason, however, why it may be worth while to keep in view the widest interpretation of the folk museum is its relation to the choice of a site The site should be such as to admit of expansion beyond immediate needs The Report mentions two possibilities. one, the ground in Regent's Park at present occupied by the Royal Botanic Society, which it is said is to be vacant in 1932, and second, the grounds at Chiswick House, of which the extent is 66 acres A possibility which has been put forward in the daily press, but is not mentioned in the Report, is the Forest of Dean. As regards the last named, most, we venture to think, will be in agreement with the Report when it says that the site should be in or near London. It is imperative, however suitable the site in other respects, that it should be readily accessible to the largest possible number of students and visitors. As regards space, it should have sufficient acreage to allow for the setting up of a number of peasants' dwelling-houses of various types and periods with gardens when appropriate, say at least ten acres, perhaps even twenty, and provision must be made for administrative offices and the exhibition of smaller objects, amulets, personal ornaments, and the like, which it would not be advisable to exhibit in the dwelling-houses.

It is obvious that such a site will not be easy to find in or near London At Chiswick House both house and grounds have a marked individuality which does not lend itself to providing an environment adaptable to the character of peasants' cottages, even if the claims of the public under the agreement by which the property has been entrusted to the local authority permitted the cession of a sufficient area of land to the museum. Regent's Park is ideally central in position, and it is doubtful if a better site could be found; but being Crown land in one of London's great open spaces, the suggestion has been criticised on the ground that this land should no longer continue to be enclosed. If, however, the open-air museum were instituted as a part of our national collections and, therefore, open to the public, this objection would lose much of its force On this aspect of the matter, however, the Report is anything but encouraging. It holds out little hope that the deficiencies to which it directs attention will be met from public funds Here it again invokes the private benefactor

An enterprise of the magnitude and importance of an open-air folk museum should undoubtedly be a national concern, but if present financial conditions preclude government action, is there any alternative? The institution of a folk museum is a question of which the urgency has long been apparent It had been under the consideration of the Council of the Royal Anthropological Institute even before the appointment of the Royal Commission. A committee was formed, which has since been strengthened by the addition of representatives of scientific bodies most actively interested in this matter A site alternative to those proposed in the Museums Report has been offered to the committee It possesses many advantages and the price is low. But, clearly, no body of this character could enter upon an undertaking of such magnitude without the assurance of considerable public support, and only in the last resort when all efforts to secure the performance of an obvious public duty by the State had failed.

## The Universe.

*The Universe Around Us.* By Sir James Jeans. Pp. x + 352 + 24 plates. (Cambridge. At the University Press, 1929) 12*s*. 6*d* net

THIS book is an attempt to picture, in language which any intelligent reader can follow, the universe around us, from its greatest to its minutest features Astronomy has undergone, in the last generation, a peaceful development which is greater than a revolution. It has become universal. The change of base from the solar system to the stars is a greater change than the change from the earth to the sun, and the consequences are not the less momentous because in this case the change has been made without conflict or opposition. That some such change must be taken, at some future time, has been obvious. In the past, guess and forecast have always fallen short of the facts, and in any case they are repugnant to those who value facts and see how the impressive scheme of astronomy has been built up by following the rule of never saying more than we know. But the means of gaining knowledge seemed wholly inadequate to cope with the question. There seemed no hope of getting a trustworthy outline in our time,

or in any other time that we could look forward to. But this is now changed.

The universe, however, must be described not only in terms of stars but also in terms of atoms It extends like a series of numbers upwards to the very big and downwards to the very little It extends forwards and backwards in time, as well as in space, and to gigantic as well as to minute intervals of time We, who have to evolve a picture of this scheme, are literally a mere point, placed somewhere in the middle of it, with literal infinities extending before and after us, beneath us and above us, going out beyond the grasp, or even the intelligible conjecture of sense Descartes conjectured that God might create the world anew every instant. It would save many difficulties if we could believe Failing that explanation, we must first invent memory to carry us from instant to instant, and then rationalise its record, and extend it to history and prehistory, and even then, as a geometer would put it, we have only succeeded in drawing a tangent line, whereas our business is with the whole of the curve, and how are we to reach it ?

The present book, as Sir James Jeans tells us, had its origin in some broadcast talks It is an unsatisfactory origin, for the broadcaster, even more than the lecturer, cannot be confronted with what he said last, and is tempted to sharpen his points and exaggerate his emphasis in the effort to 'put it across' in the briefest time, to an unseen, unknown, and very numerous audience. So far as the origin can be traced in the book, it is nothing but a disadvantage, but it amounts to little The early part of the book is perhaps a little disjointed and breathless. Those who know Jeans's other writings will notice with surprise another feature, an occasional careless phrase A "celestial pepper pot" is, like the "beautified Ophelia", "an ill phrase, a vile phrase",—so is "opinion is rather in the melting pot". If Sir James Jeans has left these things in his pages, it is only because he could not be bothered to weed them out. That, in fact, is the note of the book, and gives it, in my judgment, some of its impressive force. The many passages of real and spontaneous eloquence in it gain rather than lose from standing side by side with such careless but efficient words. Some of the facts related are fairly familiar to scientific readers, but that could scarcely be avoided if the book is meant for all. The impression left is that of a man who, as we know, has ranged to and fro over the whole of mathematical physics, and has contributed a great deal in different places to the establishment and precision of its ideas, and who now tells us what he thinks of it all, without any catch-penny phrases, without any jokes, as the expression of an intense personal interest, which would be infectious in any case, but is much more so from the knowledge of the competence of the author.

It is worth while to see how it comes that a complete and convincing picture can now be given, answering all the main questions, over an area that seemed a little time ago far too extensive and remote to get any real knowledge of it Take the scale and extent of the astronomical universe The material contributed by the great American observatories, especially Mount Wilson, is striking Nine out of ten of the beautiful plates that illustrate the volume are drawn from that source. Without them, much that is now clear would go unverified The immense advantages conferred by the great telescopes and the Californian skies are evident.

Material resources, however, are not everything. No one, least of all the astronomers of that great observatory, would make such a claim The very reason their efforts have been so well directed, and the material they have provided has been so well used, lies in the widespread interest that is felt for these problems in every part of the world, by which, wherever an alert mind was found, it contributed to putting a significant question, and then to threshing out the conclusions from the results that were furnished. Usually this has to be done several times over before people are satisfied. Replace America and Mount Wilson by England and Cambridge, and very much the same is true of the atom Improved communications of all kinds have enormously increased the speed and efficiency, and cumulative power, of scientific investigation The outcome as shown in this book is a description which offers answers to almost every physical question we want to put, and one which has been so closely criticised that we cannot believe it can be seriously shaken anywhere.

What, then, is the outcome ? The infinitely great and the infinitely little are terms that have been used for a long time, and to speak in the vernacular, 'they didn't cut much ice'. The most remarkable feature of the new cosmogony is that it is queer. At both ends It is as queer and unintelligible as life and morals have long since been voted, by those who have studied them. Many people have recognised from an early date that the quantum theory was really more disruptive of preconceived ideas than relativity itself. The more we look at it the more inevitable the fact is. We require to

keep two contradictory views in use at once. That does not baffle the theorists, who have brought in matrices, with their two different products as the norm, and reduced it all to calculation But the price is that we must once and for ever abandon the guidance of our senses; and if this *is* ultimate reality, we do not know what it means, now that we have found it

Scarcely less bewildering is the view in the cosmic field. We have long since known that the universe presented a spectacle of the degradation of energy. Now that we know, more or less, what the universe is, we see what that statement means. Cosmic rays, derived apparently from the mutual extinction of protons and electrons, are flying in great quantity in all directions. There are some millions of great nebulæ, the nearest so remote that its light takes nearly a million years to reach us These great nebulæ are gradually collecting from the all-but-void, and each is degenerating into clusters of hundreds of thousands of stars. Each star lives on the extinction of its own matter. The sun, for example, loses four million tons a second, and out of its year's output, a small fraction of one second represents what we happen to intercept and on which we keep going. The extent of the universe in time and the absence of any significant happening is just as remarkable. What is all this universe for? Who wound it up? When? Why? Vain questions. The universe did not exist for any of us a hundred years ago, and it will cease to exist in any physical sense even more briefly.

But if these are vain questions, it is far from a vain pursuit to write a book like the present one. Here is the physical outline of the world, and unless our intellect is totally misleading, it cannot be much wrong. Unless we are prepared to assert that it is, everything else must square with this frame. All current beliefs must be overhauled so that they may fit into the picture, and a great many of them, fundamental and otherwise, will suffer severely before the process is complete.

R. A. S.

## Discovery and Invention.

*A History of Mechanical Inventions*. By Prof. A. P. Usher. Pp. xi+401. (New York. McGraw-Hill Book Co., Inc; London: McGraw-Hill Publishing Co., Ltd., 1929) 25*s*. net.

"The history of the development of the inventive faculty", said Mason in his "Origin of Inventions", "is the history of humanity", while the term invention, used in its plain logical sense, he added, may be applied not only to mechanical devices but also to the processes of life, languages, fine art, social structures and functions, philosophies, formulæ, creeds and cults, all of which involve over and over again the same activities of mind

Though applicable to the whole range of human endeavour, by common usage invention is associated in our minds with tools, utensils, appliances, instruments, machines and engines, and we all think of the inventor as one who troubles himself with such things Even with this restricted significance, the history of invention takes us back to the most remote age and into every corner of the world, and opens up as fascinating a study as can be found anywhere else and one that touches life on every side Between the fashioning of the most primitive knives, needles, snares, weapons, rafts, and shelters, and our complex machinery, our powerful engines, our instruments of refinement and precision, lies the history of material civilisation

In spite, however, of the interest and importance of the subject, there are few books dealing with it in a critical or general manner. Certain branches of invention have had their historians, and there are a few biographies of modern inventors and reviews of definite periods, but these do not meet the needs of the ordinary reader. It is with pleasure, therefore, we direct attention to Prof. Usher's series of sketches dealing not only with some of the most notable of mechanical inventions, but also with the place of technology in economic history and with the process of invention itself, a process in which the powers of imagination are fully employed Dismissing the view that the process of innovation is a phenomenon more mysterious than other phases of our mental life, the author discusses the nature and theory of innovation, distinguishes between discovery and invention, and shows how the development of modern experimental science laid the foundation of our modern technology. Writing of the function of the fore-conscious mind in invention, he says:

> The inventor, like the artist, lives on the border land between the normal and the abnormal, and, like artists and prophets, finds in his day-dreams a source of gratification and encouragement at the least, and at times a fruitful source of genuine accomplishment.

The opening chapters are as fresh and stimulating as they are unusual in a book on invention, and it may be presumed that we owe Prof.

Usher's psychological studies to the fact that he writes as a professor of economics and not as a technician

Of inventions themselves we are given chapters on the mechanical equipment of the pre-Christian era, on water wheels and wind mills, water clocks and other time-keepers, the invention of printing, the textile industries, and the production and application of power Only one inventor has a chapter to himself, this exception being that remarkably versatile genius, Leonardo da Vinci. Famous as an artist and as constructor, there is certainly no ground for the view that his scientific and mechanical capacities were in any way inferior to his artistic powers

Right throughout the book emphasis is placed on those inventions which, in Prof Usher's words, exhibited primary synthesis rather than critical revision, and attention is directed to the innovations which led to notable and fundamental advances. The book is well illustrated; authorities are quoted; there is a valuable bibliography and a satisfactory index It undoubtedly fills a gap in the list of English works on invention and should be valuable to many classes of readers, and especially to those engaged in teaching economic and industrial history.

## Pharmaceutical Products.

(1) *Kraemer's Scientific and Applied Pharmacognosy.* Third edition, thoroughly revised by the following named Editorial Committee: Editor-in-Chief, Dr. Edwin L Newcomb, Co-Editors, Prof. Leasure K. Darbaker, Prof Earl B. Fischer, Prof Edmund N. Gathercoal Pp xxxvii+893. (New York: John Wiley and Sons, Inc; London: Chapman and Hall, Ltd., 1928.) 37*s* 6*d* net

(2) *Handbook of Pharmacognosy.* By Dr. Otto A. Wall Revised by Prof Leo Suppan. Fifth edition Pp 472. (London: Henry Kimpton, 1928.) 21*s* net

(1) DURING the past few years the study of crude drugs derived from the vegetable and animal kingdoms has attracted an ever-increasing amount of attention, and the interest in this branch of knowledge has shown a remarkable revival. Medicinal plant farms, where the changes effected in the constituents of medicinal plants grown under varying conditions can be studied, have been established in increasing number. In that respect Great Britain has shown a tendency to lag behind, due probably to a lack of that public support which is freely given on the Continent Striking evidence of the interest taken in this subject abroad is shown by the success attending the conferences recently held in Budapest and in Venice by the international association for the promotion of the production of medicinal plants The authors of "Kraemer's Pharmacognosy" have every justification for the statement they make in the preface that "pharmacognosy must play an increasingly important part in the future of pharmacy and medicine".

Pharmacognosy now involves so much botany, chemistry, pharmacology, and other sciences, that the decision to entrust the revision of the third edition to an editorial board of four members must be regarded as justified. The general plan of the work has been retained, but about fifteen new monographs have been introduced and the size of the volume increased by about 130 pages. The number of drugs discussed is therefore very large, in fact, it might safely be said that the work contains information upon most drugs of importance

There are numerous illustrations of varying quality, many being good and some indifferent, while in other cases it is rather difficult to find a reason for their introduction.

Organotherapy, vaccine therapy, serum therapy, and protein therapy have of late made notable additions to the armamentarium of the physician, and of these pharmacognosy must take cognisance Accordingly, the book contains brief allusions to vaccines, sera, etc., and also an account of the collection of pollen for diagnostic and curative use. Under the heading "Animal Drugs" the editorial board says, "Their study is much neglected by students of pharmacy, and more attention should be given them as they furnish some of the most important drugs used by man". In view of this statement, it is rather remarkable that the only animal drugs discussed in the book are cantharides, cochineal, musk, and civet. One would have expected to find descriptions of the thyroid and pituitary glands, which are official in the U.S Pharmacopœia, of the suprarenal glands, of the pancreas and others, but nothing beyond a mere mention of them in the course of half a dozen lines is to be found. Nor is there any mention of such animal products as cod-liver oil, spermaceti, beeswax, or woolfat.

Possibly these substances were regarded by the editorial board as outside the scope of pharmacognosy, but it is not easy to ascertain whether this is really the case. On page xlv the following state-

ments are to be found "Pharmacognosy is essentially the study of organic drugs and allied products", "In a more restricted sense pharmacognosy embraces the study of medicinal plants and their crude products", "in short, pharmacognosy deals with the properties, identification, sources, and nature of new materials and their products", "the ultimate aim of the science of pharmacognosy is to obtain a knowledge of the chemical nature and the properties of all commercial products from their origin in nature to the final changes produced in their manufacture". What, then, *does* the editorial board really understand by pharmacognosy?

A careful examination of the accounts of at least the more important drugs reveals deficiencies and inaccuracies that should not occur in a work of this description. The collection of acacia gum and of benzoin, for example, leaves much to be desired; the constituents of benzoin and of ammoniacum do not correspond with the results of recent investigation; cathartic acid still occurs as one of the three active constituents of senna, and so on Had the authors been acquainted with the thorough examination of santonica made by Wallis and Mowat, they would probably have modified their account of it, but it is remarkable that reference to an English literary source of information is rarely to be found.

The work is one of the best known and probably one of the best of American text-books of pharmacognosy. It contains abundant information, but it would appear that in preparing the present edition sufficient care was not given to revising the text, correcting inaccuracies, introducing the results of recent researches, and generally bringing the work abreast of the progress of pharmacognosy.

(2) This work was originally written to serve as notes in pharmacognosy for students in colleges of pharmacy, in order to relieve them from the labour of taking notes and leave them free to follow the information and explanations given by the lecturer. It would afford, therefore, a skeleton to be clothed later with muscle by the student himself in the course of his post-graduate study. Such a method of dealing with pharmacognosy is by no means new, and while it appears at the first glance to possess advantages, it suffers from the danger that the student may neglect to provide the muscles for the skeleton and content himself with a collection of dry bones, relying chiefly upon his memory instead of upon his understanding

As the book has now reached its fifth edition and Prof. Suppan has retained this method of dealing with the subject, it must be assumed that the object in view has been attained and that the student has been provided with and uses a condensed outline of pharmacognosy which he can afterwards amplify as opportunity offers A student seldom makes satisfactory progress in a subject in which he is not interested, and whether this method of presenting it will attract and interest him and stimulate him to further independent inquiry is to be doubted, probably it will not The information, though given in a very condensed form, is on the whole fairly accurate Errors are to be found, as indeed they are to be found in all books, but as a rule they are of minor importance

Numerous illustrations accompany the text and serve their purpose, although some of them lack artistic finish It is doubtful whether the book will meet with a ready outlet in Great Britain. It is not suited for class work for English students, and is not sufficiently thorough or detailed to be useful as a work of reference.

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## A "Handbuch" of Zoology.

*Handbuch der Zoologie. eine Naturgeschichte der Stamme des Tierreiches.* Gegründet von Prof. Dr. Willy Kukenthal. Herausgegeben von Dr. Thilo Krumbach. Band 2: *Vermes Amera, Vermes Polymera, Echiurida, Sipunculida, Priapulida.* Lieferung 1, Teil 1. Pp. 112. 12 gold marks. Lieferung 2, Teil 8. Pp 112. 12 gold marks. Lieferung 3, Teil 2. Pp. 128 14 gold marks. Lieferung 4, Teile 3 und 4. Pp. 110+18. 14 gold marks. Lieferung 5, Teil 4. Pp. 19-146 14 gold marks. Band 4 *Progoneata, Chilopoda, Insecta.* Lieferung 6. Pp. 577-672. 10 gold marks. Lieferung 7. Pp. 673-800. 14 gold marks. Band 6: *Acrania (Cephalochorda), Cyclostoma, Ichthya, Amphibia* Halfte 1, Lieferung 1. Pp. 112. 12 gold marks. Band 7. *Sauropsida, Reptilia, Aves.* Halfte 2, Lieferung 3. Pp. 225-336. 12 gold marks. Lieferung 4. Pp. 337-432. 10 gold marks. (Berlin und Leipzig. Walter de Gruyter und Co, 1928.)

SINCE our last reference to this fine "Handbuch", ten parts—1056 pp.—have reached us, and it may be said at once that they fully maintain the standard of the earlier parts both in text and illustrations.

The second volume on a portion of the Vermes is to consist of nine independent parts, five of which have been published during the last twelve months. In this volume the accounts of the Amera—the

flatworms and roundworms—and the Polymera, that is, the Annelida, including the Echiurida, Sipunculida, and Priapulida, will find a place. The description of the Myzostomida has appeared in the first half of the third volume, and the Oligomera—Phoronis, Bryozoa, Brachiopoda, Chætognatha, Rhabdopleura, Cephalodiscus, and Enteropneusta—are to be considered in the second half of that volume. A brief general introduction to the Amera is given in Bd. 2, Lief. 1, Teil 1, by Dr. E. Reisinger, who, in a paragraph on the phylogeny, derives the Gastrotricha and therewith all Nemathelminthes from the Platyhelminthes, particularly the Rhabdocœl Turbellaria. A definition and short consideration of the morphology, development, and phylogeny of the Platyhelminthes are given by Prof. E. Bresslau and Dr. Reisinger, who set aside the theory of the relationship of Ctenophores and Polyclads. They regard the similarities exhibited by the Platyctenidæ and the Polyclads as due to convergence and they consider the Acœla to be the most primitive flatworms. Prof. Bresslau then proceeds to the detailed description (unfinished) of the anatomy and finer structure of the Turbellaria, the alimentary and nervous systems being well described with the help of many excellent figures, the majority of which are from recent memoirs.

Part 8 of the second section of this volume contains a compact account in 112 pages of the Oligochæta by Prof. W. Michaelsen, who has himself added so greatly to our knowledge of this class. His account of the finer structure of the nervous system is, however, disappointing—it gives no idea of the nature and relations of the neurones, and there is no satisfactory description or figure of the funnel of the nephridium of *Lumbricus*. But for much of the anatomy, and for distribution and ecology, and features used in classification, the account is excellent.

In part 2 of the third section, Prof. Otto Fuhrmann deals with the Trematoda—first with the Monogenea (pp. 29), and then with the Digenea, the account of which is unfinished. The text is supported by 171 well-drawn figures illustrating the anatomy and development of a representative series of examples.

Prof. L. Bohmig, in parts 3 and 4 of the fourth section, gives a good account of the structure, physiology, development, classification, and relationships of Nemertines. A figure showing the anatomy of *Malacobdella* would have been useful here. Following is a brief introduction to the Nemathelminthes, which are defined as including the Nematoda, Nematomorpha, and Acanthocephala, and also the Rotatoria, Gastrotricha, and Echinoderida. Dr. Wesenberg Lund's account of the Rotifera begins in this part and occupies the greater part of part 4 of section 5—altogether 120 pages—and, as would be expected from this author, such aspects of the subject as sexual and seasonal dimorphism, the life-cycle and the duration of life, and ecology receive full consideration. Dr A Remane's account (unfinished) of the Gastrotricha follows.

In sections 6 and 7 of the fourth volume is the first part of the account of the insects—the Apterygota and the lower Pterygota—by Dr A Handlirsch. Ample space is devoted to external features, dimorphism, larvæ and nymphs, fossil representatives, phylogeny, habits, ecology, distribution, and classification, but much more information might have been given on internal anatomy, and in some cases on physiology; scarcely any reference is made, moreover, to the finer structure (histology).

The account of *Amphioxus* (unfinished) by Dr. V Pietschmann (Bd. 6, Halfte 1, Lief. 1) includes an excellent description of the anatomy and histology, especially of the nervous system and sense organs The account of the development is illustrated almost entirely by Hatschek's figures (with the polar mesoderm cells); it would have been well to include some from later investigators. The description and figures of the metamorphosis are inadequate.

In the seventh volume (Hälfte 2, Lief 3, 4) Dr. E. Stresemann continues his account of the birds, describing the urinogenital system, sperm and ovum, development, hatching, the nestling and its down, the flight feathers, sexual dimorphism, differences in structure between the two sexes, and gynandromorphs. Beginning with the primary germ cells and their migration into the splanchnopleure, the history of the gonad in the embryo in both sexes is traced, and the seasonal changes of the adult gonads are noted. The section on development is relatively short, the author perhaps considering that, in view of Lillie's masterly volume on the subject, brief treatment was permissible. Nests, eggs, social life, parasitism—the case of the cuckoo and others—receive very adequate consideration, and the majority of the illustrations are from recent works and form an excellent support to the text.

The publishers deserve the support and encouragement of all zoologists for their enterprise in producing this comprehensive and valuable "Handbuch".

## Our Bookshelf.

*Biological Principles: a Critical Study.* By J. H. Woodger. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xii + 498. (London: Kegan Paul and Co., New York: Harcourt, Brace and Co., 1929.) 21s. net.

No doubt most thoughtful biologists deplore the small number of generalisations which exist in their science compared with the ever-increasing masses of unrelated facts reported by workers in field and laboratory. Evidently some attention to fundamental concepts is required, and Mr. Woodger has made an attempt to survey critically the primary suppositions which are involved in biological thought. His book begins with a discussion of the relations between natural science and philosophy, including a vigorous attack upon phenomenalism. Mr. Woodger is for the most part a follower of Prof. Whitehead and the Cambridge school of logicians. The book then gives an account of the principal antitheses of biology (vitalism-mechanism, structure-function, organism-environment, preformation-epigenesis, teleology-causation, mind-body), mediating between them and mitigating the bitterness of their opposition. Finally, the author ventures on a discussion of the future of biology.

Mr. Woodger's very difficult task has been accomplished so successfully that no biologist who really wishes to face fundamental problems should omit to read it. Yet it suffers from three defects: (a) it is unnecessarily long, because unnecessarily polemic, especially against text-book statements; (b) it attributes to physiologists, biochemists, and others with whom the author is not in sympathy, opinions much cruder than those they actually hold; and (c) it is insufficiently constructive. Mr. Woodger tends to destroy without replacing. Thus on p. 315 he says, "It will be necessary to devise ways and means for correcting a purely analytical procedure", but there the question is left, though most biologists would agree as to the importance of the way the parts are related; the difficulty is to investigate without destroying. Perhaps Mr. Woodger will some day give us a better, shorter, more constructive book, suggesting methods of research better than those now in use, instead of simply pointing out their deficiencies.

*The Soul of Manchester.* Edited by Dr. W. H. Brindley. (Published for the Manchester Section of the Society of Chemical Industry.) Pp. xi + 280 + 16 plates. (Manchester: Manchester University Press, 1929.) 6s. net.

THIS interesting compilation, finely illustrated, commemorates the meeting of the Manchester Section of the Society of Chemical Industry, held in the city this year, and is very welcome. It is in no sense a guide-book, but a critical valuation of the activities—scientific, literary, educational, industrial, and general—of a centre which has long played a conspicuous part, for good and all, in the evolution of human affairs within and outside its borders. Authorities such as Sir Henry Miers, Prof. A. Lapworth, Prof. C. H. Herford, Sir Michael Sadler, Prof. F. E. Weiss, Prof. C. H. Reilly, Dr. Henry Guppy, and others recount success, failures, and future aspirations.

The attractiveness of citizenship lies, doubtless, in its fundamental diverseness. We would like to be told, in similar vein, of the soul of Liverpool, of Sheffield, Birmingham, Bristol, but realise the civic hardihood involved in such ventures. As for London, she must ever stand alone, mother of our cities, in spirit dominant.

The title of the book is fully met in able articles. These include "The Story of Education", "The Face of Manchester", "Chemistry and Manchester University", "Manchester and Cotton", "Social Service", "Manchester and Recreation". An informing contribution, "Manchester and its Press", recalls Alex. Ireland, sometime manager of the defunct *Examiner*, who came to Manchester from Edinburgh, where he had been associated with William and Robert Chambers. He was the only man in the country, we are told, in the secret of the authorship of "The Vestiges of Creation".

*Evolution by Symbiosis.* By H. Reinheimer. Pp. viii + 141. (Surbiton: Grevett and Co., Ltd., 1928.) 5s. net.

IT is not very easy to deal with Mr. Reinheimer in a short notice; but at the same time one cannot feel sure that he deserves a longer one. This book is but one of a number which he has written, all telling the same story, namely, "that the standards of virtue and vice in the universe depend upon two antitheses: symbiosis and parasitism; that it is definitely immoral and ruinous, through the whole of nature, for an organism to be parasitic; that the degree of virtue is the degree in which an organism co-operates or 'gets on' with the universe, living by helping the rest of creation" (p. 8). "Only austerely constituted organisms can hope to enjoy natural immunity from disease" (p. 23). A carnivore is a "semi-degenerate organism" (p. 44), "there is but a difference of degree between carnivorism and parasitism" (p. 45); "symbiotic cross-feeders [that is, herbivores] are *ipso facto* in due relation with the world of life and thereby best qualified to enter into fruitful, sympathetic and intelligent social intercourse of the most varied kinds" (p. 56), so long as they do not overdo it and become "plant-assassins" (wasteful and destructive herbivores) like the elephant, which is "a typical acromegalic animal in a state of hopeless senescence verging on extinction" (p. 109).

Mr. Reinheimer has produced a great bulk of argument in favour of his views, and it must be admitted that some of his ideas are clearly important, whilst others are at least interesting; for example, a study of animal nutrition is obviously a necessary part of any comprehensive study of evolution. But Mr. Reinheimer spoils his own case by being peevish with biologists who do not accept his views. "Orthodox biology is written, as I have often said, to suit the perverted digestion of modern society" (p. 51). He has a favourite phrase, "as

I have often shown". our objection is that he has *not* shown we should be more grateful to him for a single piece of detailed original research bearing on the question of evolution, such as Heslop Harrison's work on the inheritance of melanic varieties in certain Lepidoptera, than for any amount of argument.

*Researches in Polynesia and Melanesia; an Account of Investigations in Samoa, Tonga, the Ellice Group, and the Hebrides, in 1924, 1925* By Patrick A Buxton Parts 5-7 (relating to Human Diseases and Welfare) (Memoir Series, No. 2) Pp xi + 139 + 27 plates (London London School of Hygiene and Tropical Diseases, 1928.) 9s.

FEW problems of tropical medicine are more complex than that of the pathology of filariasis, it is one which for elucidation will require extensive research, carefully planned and properly standardised Dr Buxton's contribution to the problem forms Part 5 of the account of the investigations in Polynesia and Melanesia undertaken by the expedition sent out by the London School of Tropical Medicine It bears the stamp of strictly scientific medical research The methods and technique adopted are described in minute detail, statistics are complete and precise; a well-reasoned commentary concludes the account, and numerous references and cross references enable the reader to verify readily the evidence on which the author's deductions are based. Considering the conditions under which research work in Oceania is carried out, Dr. Buxton is to be congratulated on the complete and exact nature of this record.

The study in filariasis forms the principal part of the book. Parts 6 and 7 are devoted to a consideration of other human diseases in Oceania, and the effect of European culture on the Samoan The text is illustrated by a series of excellent photographs.

*The Mind of the Savage.* By Raoul Allier Translated by Fred Rothwell. Pp. xiv+301. (London: G. Bell and Sons, Ltd., 1929.) 15s. net.

THIS is the translation of a book which appeared first in 1927 under the title "Le non-civilisé et nous". The author, during a long life devoted to the study of Protestant theology in the University of Paris, has been closely associated with missionary work, especially in Madagascar. His study of the psychology and sociology of primitive peoples, which has proceeded concurrently with his activity in the administration of missions, has therefore had a strong practical bias throughout, which appears, as the original title shows, in this exposition of his conception of primitive mentality. The main line of his argument is aimed at demonstrating the disastrous and paralysing effect of the belief in magic in all departments of primitive life and activity. One point he brings out of which perhaps too little has been made hitherto, and that is that magic involves not so much the association of ideas as the association of emotions. He ranges himself with Lévy Bruhl and other French psychologists as against the English school To some at least of the latter school his conclusions will appear too abstract and 'to smell of the lamp' In other words, his view of the function of magic is external and ignores recent work which has studied it as an integral element functioning in a given social environment The concluding chapters are practical in their bearing and deal with "A New Philosophy of Colonisation" and the rôle of Christian missions

*Trout Fisheries: their Care and Preservation* By J C Mottram. Pp 186 (London. Herbert Jenkins, Ltd, 1928) 10s. 6d net

To have the fortune to own or lease trout streams of the first order is the lot of few, and reading Mr Mottram's book causes one to wish for some such water on which to experiment Certainly, those who have this good fortune should not fail to study this work, which contains much practical advice, it should also be in the hands of those who control the many associations which maintain the fisheries of the streams and lakes with which the British Isles abound.

Of special interest is the chapter on trout disease and restocking, in which the author directs attention to recent research on the causes of outbreaks of disease in large populations and the dangers of introducing healthy stock into populations which have already passed through an epidemic, thus incurring the risk of starting the disease afresh owing to the weak resistance of the new blood The dangers of introducing possible carriers of furunculosis are also stressed, a subject the study of which has recently been taken up by a joint committee under the auspices of the Fishery Board for Scotland, the Ministry of Agriculture and Fisheries, and the Kennet Valley Fisheries Association,

The book is very clearly printed with large type and makes pleasant reading. The insertion of photographs to supplement some of the line diagrams would perhaps have been an improvement

*Medical Adventure: some Experiences of a General Practitioner.* By Dr. Ernest Ward. Pp xii+291. (London. John Bale, Sons and Danielsson, Ltd, 1929) 8s. 6d. net.

THE enjoyment with which many readers of the *London Hospital Gazette* have perused Dr. Ernest Ward's articles will be shared by all who read his book "Medical Adventure". Written with a literary ability rarely found in medical men, every chapter reveals the author's powers of observing and recording, and, when in lighter vein, his keen sense of humour. His accounts of difficult and amusing situations, of cases common and uncommon, of successes and failures, give a really unique description of a general practitioner's work. His reflections on many problems are most instructive, but are offered with unassuming modesty. To the young practitioner especially this book will prove of great value; from it he will learn lessons as readily as if he had himself experienced Dr. Ward's adventures

## Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Severe Environmental Mortality among *Abra* (=*Syndosmya*) *alba*, *Donax vittatus*, and other Organisms off the Lancashire Coast.

WHILST walking along the Birkdale sands from Ainsdale to Southport on the Lancashire coast on Nov. 3, I noticed that immense numbers of small molluscs had recently been washed ashore, and as definite observations on environmental mortality are important in connexion with the adaptations of a species to its environment, such occurrences are worthy of record.

The spring tide had begun to ebb as I set out to walk from Ainsdale to Southport along the high-water mark at midday, and my attention was at once attracted by large numbers of tubes of *Pectinaria* and *Lanice* (=*Terebella*) and shells of *Abra alba* (=*Syndosmya*) Wood. The tubes of *Pectinaria* were empty, while those of *Lanice* constituted only the upper portion and, though obviously fresh, like those of *Pectinaria*, were also empty. These tubes occurred along the whole stretch of the sands examined, either in rows or piles, at and near the high-water mark, and the mortality in *Pectinaria* may be estimated to have been of the order calculated for *Abra* below. Probably no or little mortality occurred in *Lanice* owing to the habit of this animal of retreating down its deeply embedded tube at a rapid rate when disturbed. *Pectinaria*, having a cone-shaped tube, cannot retreat in this way and must perforce become exposed when its tube is washed out of the substratum.

Shells of *Abra* were also distributed along the whole of the region of the high-water line from Ainsdale to Southport, either in heaps in stream-lines or in crowded rows along the high-water mark or scattered over a strip of high-water wash-mark varying from about 5 to 10 yards mostly, according to the contour of the high-water region. The shells were entire and fresh, and on the return journey from Southport to Ainsdale it was estimated that from 25 to 50 per cent of them contained either living or recently dead tissue. A sample of the shells with soft parts remaining was examined in the laboratory on the same and following days, when living tissues were found. Living Trematode larvæ were also found in seven or eight individuals out of about 12 or 13 examined, one individual being heavily infected. There can be no doubt, therefore, that the *Abra* as well as the *Pectinaria* and *Lanice* had been washed ashore during a few recent (and spring) tides.

An attempt was made to estimate the number of *Abra* present on the strip of shore examined. In representative areas where the shells were scattered thinly, two counts in about a square foot gave about one in 10 sq. inches. In thicker collections at a typical place at the higher water-line there were about three per 10 sq. inches. In still thicker concentrations of common occurrence there were 20 in 10 sq. inches, and in a typical stream-line collection, of which there were abundance, 25 occurred in 10 sq. inches. Still thicker concentrations occurred where heaps of *Abra*, *Pectinaria*, and *Lanice* occurred to a depth of one to two inches or possibly deeper, but sometimes these heavier concentrations coincided with a sparsely besprinkled high-water zone. On the minimum estimate of a thickness of 14 *Abra* per square foot for a width of only 7½ yards along the high-tide zone from Ainsdale to Southport (fully three miles were carefully examined), it is easy to estimate that approximately 5 million individuals had been recently washed ashore on this strip of coast. But as shells were also found lower down in the tidal zone, and fishes, gulls, and other animals had in all probability fed on them, in addition to the thicker concentrations observed, it is probable that a more likely minimum estimation of the loss would be of the order of 10 million.

While counting the *Abra* it was observed that countless numbers of the spat of *Donax vittatus* (for the identification of which I am greatly indebted to my friend, Mr. R. Winckworth) occurred also along the high-water line, especially in stranded waves of froth. These also occurred with few exceptions along the greater part of the three miles of shore examined. At some points the spat were scattered over the high water zone, but close observation was required to detect them, as their size ranged from only about 3 mm. to 4.3 mm. No attempt was made to estimate numbers in the heaped-up masses, but 58 were picked up on a halfpenny where they were lying about one deep. In many places masses of them could be picked up in one's fingers. The loss of the spat of *Donax vittatus* may therefore be estimated conservatively as ten times greater than that of *Abra*, and therefore of the order of 100 million on this strip of coast.

As some food-fishes, for example, plaice, devour *Abra*, *Donax*, and *Pectinaria* (see the work of Todd, Petersen, Ford, Ray, and others), the mortality observed represents perhaps a not unimportant loss of potential fish-food, and demonstrates in the case of *Donax* the manner in which the whole spatfall may fail in certain years even after the critical post-larval stage is overcome.

It seems probable that the mortality was due in this case to a certain wave-action set up by a combination of strong inshore winds coincident with spring tides, whereby is produced a strong ground-swell which washes out all organisms in the surface layers of the sandy or muddy sea-bottom. It would appear that this section of the coast is peculiarly liable to disturbance of this kind, as Chaster records immense quantities of the relatively large spiny cockle (*Cardium echinatum*) thrown up alive on the same beach in January 1891 (*Southport Soc. Nat. Hist.*, i. 1892).

J. H. ORTON.

The University,
Liverpool, Nov. 23.

### Mechanism in Nerve Centres.

MACCURDY, in his stimulating book, "Common Principles in Psychology and Physiology", has assailed the mechanistic interpretation of reflex function as incompatible with known facts. He concedes that the nerve impulse, as exhibited in the peripheral nerve fibre, may be explicable on a physical basis, but he insists that as soon as we encounter the function of the nerve centre, even as exemplified in the simplest reflex arc, we are forced to recognise the presence of something quite apart from any physical mechanism. He contends that the nerve centre does not merely conduct impulses (as does the nerve fibre) but produces them. MacCurdy further objects to the assumption of physical mechanism in the nerve centre on three specific grounds; namely, a machine "cannot change itself or its functions to meet new conditions, it does not improve its performance with practice; it cannot perform some particular function depending originally on one part, after that part is destroyed".

Much has been written on the differences between conduction in the peripheral nerve fibre and in the

reflex arc which involves the grey matter of the spinal cord or brain (Sherrington, 1906 ; Forbes, 1929). The most salient differences are those of modification and variability ; modification in that the end effect in the reflex corresponds less closely to the initiating stimulus than is the case with the direct excitation of peripheral nerve, for example, when the reflex response is characterised by prolonged after-discharge or by inhibition ; variability in that the character of the reflex response is more dependent on blood supply and oxygen, and more subject to change under the influence of drugs or poisons. Yet in the case of both reflex arc and peripheral nerve, the ability to yield a functional response to an external stimulus depends on the existence of an unbroken conducting path of excitable protoplasm.

It is not clear to the physiologist why, if the principle of mechanism be admitted in the case of the nerve fibre, it should be denied the more delicate, but no less material structures in the nerve centre where the fibres branch and form an intricate network of intermingling ramifications.

Let us consider the several objections to a physical interpretation of reflex function. First, the contention that a physical mechanism cannot produce impulses may be answered in various ways. A telephone system may be likened to the nervous system, the inert wires resembling the peripheral nerve fibres, and the central exchange corresponding to the nerve centre. The switching of the incoming call to the proper line has until recently required a conscious operator, but now this function is performed by machine switching (widely used in America), an intricate mechanism without consciousness. A simpler case, and one perhaps resembling more closely the mechanism in the nervous system, would be a junctional point where fire, approaching along a train of gunpowder, initiates several fires in branching trains of powder. There would be no essential difference between the simple train and the branching train of powder, except in the mere fact of branching. The extensive spread of reflex effects evoked by stimulation of a single sensory nerve need not demand any more vitalistic explanation than such a branching of the conducting paths. Even the spontaneous initiation of impulses by the respiratory centre has a physical counterpart in the spontaneous, rhythmic disturbance on the surface of an iron wire immersed in nitric acid, described by Lillie (1928).

The second point is the contention that a machine cannot change its function to meet new conditions. This is met by reference to the toy beetle which walks to the edge of a table and, finding itself unable to go farther in that direction without falling off, turns and continues its exploration on another course. A more practical, if less spectacular, example is found in the stabiliser of an aeroplane, which automatically causes the plane to resume level flight when its course has been altered by a gust or ' air pocket '.

The contention that a machine cannot improve its performance with practice is at once refuted by the familiar fact that a new automobile improves in the performance of its function during the first 500 miles travelled.

As to the last contention, relating to the replacement of damaged parts, an ingenious mechanic might devise a number of ways in which a machine could be made to change automatically from one mode of operation to another in consequence of the failure of some of its parts ; for example, a steam pipe might be provided with an automatic valve which, if the pipe burst, would divert the steam through another pipe. Electrical devices which perform essentially this function are actually in use in electric railways.

Hull and Baernstein (1929) have described a mechanism made of polarisable cells and thermal regulators, which imitates a dozen different functions characteristic of the central nervous system. Indeed, if we grant to the evolutionary process in Nature but a small fraction of the ingenuity proved by the demonstrable facts of anatomical arrangement, we shall grant ample possibilities for the use of physical method in the attainment of reflex function.

The attempt to find a point at which the activity of the nervous system breaks away from physical law is due to the desire for a solution of the conflict between determinism, toward which physiology tends, and free will, which the testimony of our subjective experience leads us to accept. Any attempt to escape from the dilemma by postulating a non-physical function in the synapse or reflex junctional point, is temporising and inadequate as a solution of the central riddle of philosophy ; the postulate is arbitrary and, as is shown above, is not at all demanded by the nature of reflex function. Indeed, there is no good reason to suppose that the function of any part of the nervous system, viewed as a series of physical events, should be assumed to depart in any way from physical law (cf. Forbes, 1929). That which defies physical understanding is the arrangement and integration whereby the physical events become the vehicle of those elements in subjective life to which physical interpretation in itself offers no clue.

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REFERENCES

Sherrington, C. S. "The Integrative Action of the Nervous System." New Haven : Yale University Press, 1906.
Forbes, A. "The Mechanism of Reaction." The Foundations of Experimental Psychology. Clark University Press, 1929.
Lillie, R. S. *Science*, 67, 593 ; 1928.
Hull, C. L., and H. D. Baernstein. *Science*, 70, 14 ; 1929.

## The Energetic Efficiency of Photosynthesis.

IN a recent paper (*Proc. Roy. Soc.*, B, **105**, p. 1) G. E. Briggs discusses critically the determination of the radiant energy which is actually absorbed by the chloroplast pigments of the living cell. He considers that my own researches (*Ann. de Physiol.*, t. 1, p. 47, 1925) upon this subject do not provide accurate data for the determination of the relative efficiency in different parts of the visible spectrum, and that for three reasons :

(1) Because the filters used transmitted an undetermined amount of infra-red radiation.

(2) Because the calculation of energy absorbed lacks a satisfactory basis.

(3) Because the efficiency may have been limited by the rate of supply of carbon dioxide.

In a later work (*Jour. de Physique*, t. 7, p. 33, 1926), which would seem to have escaped Dr. Briggs's attention, upon this subject, I have shown that these objections are unfounded. In this research the following points were established :

(1) When the layer of water before the filter was largely increased (to 50 cm. instead of 4 cm.) in order to limit the amount of infra-red radiation, the efficiency is only very slightly altered.

(2) It is possible to calculate exactly the fraction of the radiant energy actually absorbed by a thin thallus of *Ulva*. The expression for the absorbing power deduced theoretically by Langevin and experimentally verified by me, for a thin layer of material which absorbs a part of the radiation and diffuses another part, is

$$a = \frac{2}{1 + \sqrt{1 + \frac{K'}{K}} \coth \frac{\mu l}{2}},$$

where $K$ is the absorption coefficient and $K'$ the

diffusion coefficient of the material, $\mu = \sqrt{K(K+K')}$, and $l$ is the thickness of the layer. This expression, for the case of *Ulva*, as appears on developing it in series, gives values agreeing within two per cent with those calculated from the relation

$$a = 1 - \frac{\left(\frac{I_1}{I_0}\right)_v}{\left(\frac{I_1}{I_0}\right)_d}, \quad . \quad . \quad . \quad . \quad (2)$$

where $(I_1/I_0)_v$ is the transmission ratio by the green thallus, $(I_1/I_0)_d$ the same ratio for the decolorised thallus, $I_0$ being the incident intensity, $I_1$ the transmitted intensity.

Incidentally, it is to be noted that owing to the thinness of the *Ulva* used in my experiments $(I_1/I_0)_d$ is nearly unity; hence the expression

$$a = \left[1 - \left(\frac{I_1}{I_0}\right)v\right]\left[1 - \frac{\log\left(\frac{I_0}{I_1}\right)_d}{\log\left(\frac{I_0}{I_1}\right)_v}\right] \quad . \quad (3)$$

deduced on the assumption that the living cell behaves as a homogeneous mixture of two substances which both absorb the light, gives a value not very different from the value calculated from equation (2). It is easy to show that the discrepancy in the most unfavourable conditions, when the *Ulva* is not very thin, attains ten per cent, and the discrepancy of the ratio of absorbing powers for two regions (red and green) of the spectrum four per cent.

The formulæ do not agree in the case of a green leaf. The essential reason for their agreement in the case of *Ulva* is the thinness of the thallus, but the values of the average absorbing power in different spectral regions also serve to reduce the discrepancies.

(3) The intensity of the radiation in my experiments was very low, nearly $10^{-3}$ cal./min. cm.$^2$. The carbon dioxide content of the sea water was nearly $10^{-5}$ mol per litre; and, in so far as it is permissible to compare *Ulva* and *Chlorella*, it results from Warburg's work that at this concentration of carbon dioxide, the rate of supply of carbon dioxide does not limit the rate of photosynthesis. As appears from the published data, the concentration of carbon dioxide remaining after irradiation was either the same (respiration exactly compensating for assimilation) or decreased to a minute extent.

In conclusion, it will be apparent from what has been said that Briggs's criticism of my experiments is completely unjustified. With regard to the theoretical discussion of the photochemistry of photosynthesis, I agree with Briggs. I have myself already suggested that a number of quanta varying with the frequency of radiation may be acting in photosynthesis. On the assumption that the energy to be furnished by radiation in order to break down a molecule of carbon dioxide is equal to the heat of the reaction $CO_2 + H_2O = O_2 + \frac{1}{6}C_6H_{12}O_6$, two quanta are exactly sufficient when the wave-length is 500 $m\mu$. With shorter wave-lengths the efficiency would be smaller, because some fraction of the absorbed energy would be wasted. With larger wave-lengths the efficiency would also be diminished because the absorption of three quanta would be necessary, and some fraction of the absorbed energy would also be wasted. Direct experiments to test the theory are unfortunately not easy, since the accuracy required is very high with respect to the present state of the technique, and, above all, on account of the living nature of the material.

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## A Phenomenon of the Oscillating Arc.

SINCE the experiments of the late Mr. Duddell, at the beginning of this century, it has been well known that a carbon arc fed from a direct current circuit, and with a condenser and inductance in shunt, will oscillate at a frequency which is determined chiefly by the product of the inductance into the capacity of the condenser. Much work has been done, especially in Germany, on the conditions producing these oscillations, but it does not appear to have been noticed that such an arc will oscillate violently when the shunt circuit *contains no inductance whatever.*

Experiments which we have made recently show this phenomenon to take place whether a carbon arc is used in air or a Poulsen arc in coal gas. The frequency of the oscillation (for given capacity and supply voltage) is determined by the resistance in series on the direct current side, just as in the well-known example of a neon lamp. The following table gives particulars of a series of experiments made with an open arc between solid carbons.

OSCILLATIONS WITH CONDENSER ONLY ACROSS THE ARC.

| | | | | | | |
|---|---|---|---|---|---|---|
| Direct feed current in amperes (mean) | 1·6 | 1·9 | 2·15 | 3·0 | 3·1 | 5·6 |
| High frequency current in amperes R.M.S. | 8·6 | 9·4 | 10·7 | 15·0 | 15 | 22 |
| Arc volts R.M.S. | 65 | 60 | 65 | 55 | 50 | 50 |
| Resistance volts | 190 | 192 | 185 | 175 | 180 | 180 |
| Feed volts | 250 | 250 | 250 | 225 | 225 | 220 |
| Capacity in $\mu F$ | 5 | 5 | 5 | 20 | 40 | 40 |
| Feed resistance in ohms | 119 | 101 | 86 | 58 | 58 | 32 |
| H.f./d.c. | 5·37 | 4·95 | 4·98 | 5·0 | 4·84 | 3·92 |
| Frequency | 1890 | 2280 | 2520 | 1800 | 940 | 1080 |

The very large ratio of the r.m.s. high frequency current to the d.c. feed is particularly interesting. Oscillograms taken of these discharges show the comparatively small current charging the condenser through a comparatively long period, the conductance of the arc gap meanwhile gradually increasing and the pressure rising, until breakdown of the arc gap occurs. The discharge which follows this is very large and very rapid; so rapid, in fact, that it is difficult to get an oscillograph the natural period and damping of which will record faithfully the occurrence.

As an instance of such observations on an arc 1 mm. long, the current charging a condenser of 216 $\mu$F through a feed resistance of 31·6 ohms, and with a d.c. p.d. of 215 volts, averaged 1·76 amperes, lasting for $40 \times 10^{-4}$ seconds. The maximum discharge current was 126 amperes, and the time of discharge about $5 \times 10^{-4}$ seconds.

Besides their scientific interest, these experiments are of practical importance to engineers, inasmuch as they show how a cable on any system (which has considerable capacity and little inductance) may cause violent disruptive effects if the insulation gives way at any point.

WILLIAM CRAMP.
A. P. JARVIS.

The University, Edgbaston,
Birmingham, Nov. 18.

## The Tides of the Upper Atmosphere and the Heights of Meteors.

IN NATURE of April 27, 1929 (vol. 123, p. 642), it has been mentioned that an examination of the two maxima of the frequency curve of the heights of the bases of the aurora led to the conclusion that at 70° latitude the mass of air situated above 100 km. over the ground at ebb-tide is equal to the mass of air situated above 106 km. at flood-tide.

Since then an attempt has been made to investigate the same subject by considering the heights of meteors. The material used is due to the Danish private

astronomer Torvald Kohl (*Oversigt over det Kgl Danske Vidensk Selsk.'s Forh*), and it consists of 142 measurements of the lowest observed points of meteors (*limes inferior*). The material, obtained in latitude 56° N during the years 1875–1917, is very accurate, the mean error of the heights being less than 1 km

The mean height of the *limes inferior* depends on the mass of air above this limit. Therefore, if the tides of the upper atmosphere have no phase-difference in relation to the tidal forces (which is nearly the case at ground level), the mean height of the lower limits may be expected to vary in the following manner

$$h = h_0 + l \cos 2t$$

where $h_0$ is the mean height and $l$ the amplitude of a variation depending on the moon's hour-angle ($t$) The material has been divided arbitrarily into two parts, and then each of these parts is divided in accordance with the moon's hour-angle, namely:

(1) flood-tide : $-30° < t < 30°$ and $150° < t < 210°$,
(2) +0 : $30° < t < 45°$, $135° < t < 150°$, $210° < t < 225°$ and $315° < t < 330°$;
(3) −0 : $45° < t < 60°$, $120° < t < 135°$, $225° < t < 240°$ and $300° < t < 315°$;
(4) ebb-tide : $60° < t < 120°$ and $240° < t < 300°$.

The following table gives the mean values of $h$ in kilometres:

| Years. | Flood-tide. | +0 | −0 | Ebb tide. |
|---|---|---|---|---|
| 1875–1902 | 87·7 | 90·6 | 81·0 | 79·9 |
| 1904–1917 | 92·7 | 88·6 | 78·8 | 82·8 |
| Whole period | 89·3 | 89·4 | 79·6 | 81·6 |

From these values are found: $h_0 = 85{\cdot}0 \pm 1{\cdot}2$ km.; $l = 5{\cdot}5 \pm 1{\cdot}9$ km, thus:

$$h = 85{\cdot}0 + 5{\cdot}5 \cos 2t \text{(km.)}.$$

Assuming from theory that, on an average, the meteors will be extinguished when they have passed through the same mass of air, the expression for $h$ shows that the mass of air situated above 90·5 km. at flood-tide should be equal to the mass of air situated above 79·5 km. at ebb-tide. The corresponding values formerly found by the investigation concerning the aurora were 106 km. and 100 km., respectively Taking into consideration that the former phenomenon is observed in latitude 56° and refers to heights about 85 km. above the ground, while the latter phenomenon is observed in latitude 70° and refers to heights about 103 km, a fair agreement between the two results will be found.

A further examination of other and if possible more numerous observations of lower limits of the meteors would be of importance for the investigation of the tides of the upper atmosphere. J. EGEDAL.

Geofysisk Afdeling,
Meteorologisk Institut,
Kobenhavn, Nov. 2.

## The Oxidation of Acetaldehyde by Oxygen.

IN the course of experiments which have been carried out during the last two years on the photochemical oxidation of acetaldehyde, an observation has been made which does not seem to be recorded in the literature. It has been found that when pure liquid acetaldehyde is shaken at ordinary temperature with oxygen in daylight or in the dark, a rapid absorption of gas occurs and a peroxide is formed. 2 c.c. of liquid aldehyde, shaken for one minute with oxygen, absorb more than 1 c.c of gas, and on adding the liquid to a solution of potassium iodide, iodine is liberated equivalent to about 8 c.c. of n/100 thiosulphate solution.

The formation of peroxides under these conditions from other aldehydes has long been known, and Backstrom (*Medd. K Ventenskapsakad.* Nobel Inst. 6, No 16) has recently investigated the chain mechanism of peroxide (benzoperacid) formation in the case of benzaldehyde Backstrom assumed that the photochemical rate of peroxide formation is proportional to the light intensity Mr Chatwin, working in this laboratory, has shown that the rate of benzoperacid formation is more nearly proportional to the square root of the light intensity

We have obtained similar results for acetperacid formation when gaseous acetaldehyde and oxygen are exposed to ultra-violet light. The reaction rate is high, indicating a long chain mechanism, and is approximately proportional to the square root of the light intensity, proportional to the aldehyde concentration, and independent of the oxygen concentration These facts can only be explained by a mechanism of the following type:

1. $A + h\nu \longrightarrow A^+$
2. $A^+ + O_2 \longrightarrow AO_2^+$
3. $AO_2^+ + A \longrightarrow A^+ + AO_2$
4. $2AO_2^+ \longrightarrow ?$

That is to say, the chain mechanism given by reactions 2 and 3 must be assumed to be terminated by the reaction 4 to explain the observed kinetics. This otherwise improbable mechanism is rendered possible by the great length of the reaction chains.

We are now carrying out experiments on the oxidation of acetaldehyde in solutions, and full details of all the measurements will be published when further results are obtained. E. J. BOWEN. E. L. TIETZ.

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Oxford.

## New Phenomena in a Sounding Dust Tube.

I HAVE found the clear photographs of the antinodal ring of dust in a Kundt's tube which were published in NATURE on Nov. 9, p. 724, by Prof. Andrade and Mr. Lewer of special interest inasmuch as, while using a rod excited tube and *Kieselsäure* powder, I observed (*Phil Mag*, vol 7, p. 523, March 1929) an antinodal cloud and stated that "the antinodes are marked almost as definitely as the nodes". As the dust was photographed when the note had ceased, a photograph as detailed as that of Prof. Andrade and Mr. Lewer was not obtained, although a ring-like grouping at the antinode is clearly suggested in Fig. 7 (c′) (l.c).

I have observed that the striæ tend to lean over towards the nearest antinode and, in the photograph published in NATURE, it may be seen that this tendency is marked to a minor degree. Also in my paper I pointed out that the figures depend largely on the powder used, and it would be of interest if, in their fuller account, Prof. Andrade and Mr. Lewer state the material they employed and the diameter of their tube.

Like Crofutt (*J.O.S.A and R S I.*, 14, p. 431, May 1927) I have used a valve oscillator to obtain striæ, and I was—before my experiments had to be temporarily suspended some months ago—photographing the figures kinematographically. The results of this investigation I hope to publish in due course and, in the meantime, I look forward with interest to the contribution Prof. Andrade and Mr. Lewer have promised to make to this fascinating subject.

ERIC J. IRONS.

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Nov. 19.

# 'R 101.'

By Prof. R V SOUTHWELL, F R S

AT dawn on Saturday, Oct 12, 'R 101' was taken from her shed at Cardington and brought, without difficulty or delay, to her anchorage at the mooring mast The week-end was devoted to tests of her engines and ballasting equipment, but on Monday, Oct 14, with fifty-two people on board, she left the mast and cruised for about 5½ hours over the home counties and London Such tests and measurements as could be made during the flight indicated that the airship fulfils in every way her designers' expectations, with three engines running at cruising power, an average air speed of about 58 miles an hour was maintained

On Friday, Oct 18, a second flight was made Air speeds well in excess of 60 m p.h were attained, and again the manœuvre of 'coming to the mast' presented no difficulty, although it took longer on this occasion, because the airship was found, on nearing ground level, to have an unexpectedly high 'lift' (or buoyancy). Between her first and second flights 'R 101' had been subjected at the mast to winds of considerable strength and variability, accompanied by sudden changes of temperature · her behaviour gave no grounds for anxiety, and seems to justify (so far as it goes) the preference which the Aeronautical Research Committee has expressed for this scheme of mooring in comparison with others that have been proposed. As I write, 'R 101' lies again in her shed, having left the mast to make room for the Burney airship 'R 100', due to arrive from Howden.

So for the first time since 1921, when failure of a girder resulted in the total loss of 'R 38', an airship designed and constructed in Great Britain has been seen in flight. Naturally 'R 101' has aroused great interest, and the merit of her initial achievements has been admitted even by journals which, a month ago, were fulminating at once against the mistakes of her design and the impenetrable secrecy by which those designs had been surrounded. Optimism is once more in the ascendant, and sanguine predictions are being made regarding 'R 101', 'R 100', and their successors.

The danger of such optimism is that, being a plant of very rapid growth, it is liable to wilt in the chill of even a temporary set-back; therefore I cannot feel that true service is rendered to the cause of airships by suggestions that all their difficulties have been overcome The *Times* (which almost alone among our daily papers has maintained a rational and consistent attitude towards 'this airship business') put the matter clearly in a sentence of its leader of Oct. 15: "After all, R 101 is admittedly experimental". Four years ago I stressed the same aspect in an evening discourse to the British Association[1]: "I wish that the public could be induced to see this airship construction as a great adventure: the goal, ability to fly to India, in comfort and without change, in the space of 100 hours, the problem, to design and construct a ship of vast capacity, with little help from past experience, by sheer hard thinking and hard work" Then I was pleading for (what has not been accorded) suspense of judgment on the new designs until their problems should have been worked out Now, when 'R 101's' designers are receiving the plaudits they so richly deserve, it is still the aspect of adventure that I should wish to stress, but now for the reason that, counting too confidently on success, we may slacken in determination to surmount the difficulties that remain

In 1925, only main outlines had been decided in the design of 'R 101'. I shall try to state briefly, first in what respects I consider that the anticipations of those days have been realised, and afterwards, in what respects the available evidence seems to me to be either negative or incomplete. I need scarcely add that my views carry no weight of authority, and are based on no exclusive information; my contact with 'R 101' has been solely in relation to technical problems of stress calculation, except in so far as I have been permitted by the kindness of the staff at Cardington to watch the progress of their work.

In my discourse to the British Association I ventured to defend the policy of the Air Ministry which, after four years' stagnation in airship construction, was then embarking on the adventure of ships just twice as large as any that had been built previously. I had been speaking of the "dimensional handicap"—equally ruthless in its pressure on birds and aeroplanes—which "makes our problem harder when we go to greater size", and I had said: "I do not say that we have yet reached a limit in respect of size of aeroplanes: new materials, new principles of construction and, above all, new types of engine may relieve the pressure of the laws which I have been discussing. All that I am concerned to show is that this pressure will be merely 'postponed'" But, as I went on to show, the airship, which relies for its 'lift' upon its buoyancy, "experiences a relatively insignificant dimensional handicap in the stresses which it has to sustain. . . . By doubling every dimension, we obtain an airship which will carry eight times as much load, and can withstand winds of the same strength as before." Its parallel in Nature (according to my argument) is to be found, not in the bird, but in the whale.

I urged, further, that a certain advantage can in fact be expected to accrue from increased size. "Suppose that we took an existing airship (R 33, say) and decreased every dimension by two. According to dimensional theory it could still fly and it would have adequate strength, but in reality its construction would have become impossibly flimsy. . . . Conversely, by increasing the size, and employing material of stouter gauge, we lessen the importance of corrosion, . . . we render possible methods of construction which were not practicable

[1] Brit. Assoc. Reprint No. 19.

before, . and we lessen the chance of accidental damage" I think it may be said, speaking generally, that these contentions have been sustained 'R 101' is robust, the scantlings of her steel girders are such that full advantage could be taken of experience gained in the construction of metal spars for aeroplanes, and simple joints could be provided by which the ship was assembled rapidly, as though from the elements of a vast 'Meccano' set What this means in simplicity of construction can be realised from Fig. 1, in which two typical joints are compared,—one from 'R 101', the other of 'Zeppelin' construction, and both fulfilling almost exactly the

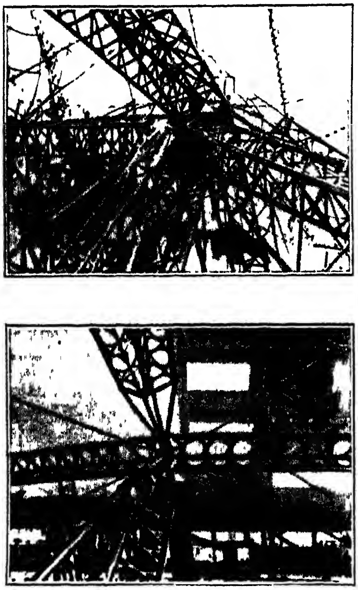

FIG 1 —Typical joints above, of 'Zeppelin' construction, below, from 'R 101' Royal Air Force official Crown copyright reserved.

same purpose. The 'Zeppelin' joint involves a large amount of hand riveting *in situ*: in 'R 101', finished members are assembled by a mere insertion of bolts and nuts.

In one respect, admittedly, the advance to greater size was an advance into the region of the unknown. It is a commonplace of aerodynamical theory that model tests, in the present state of knowledge, afford no certain indication of the characteristics to be expected in the full-scale. Therefore at the National Physical Laboratory, when we based on such tests our recommendations in regard to shape of hull, we were careful to make only guarded estimates of resistance (that is, of speed), and to emphasise that the amount of 'balance' suggested for the control surfaces might prove on trial to be either insufficient or excessive. We believed that our estimate of speed would prove to be conservative, and that the hull would be satisfactory in respect both of stability and control; but we hesitated to base quantitative figures on models which had perforce to be made on a scale of about 1/20 inch to 1 foot, and Cardington accordingly decided to provide 'Servo-motor' auxiliaries for working the controls, in case these should prove 'heavier' than was expected

According to the *Times* report of Oct 16, 1500 h p sufficed in the first trial to give the airship a speed of 58 m p h It may be deduced with practical certainty (since the power required will vary as the cube of the speed) that with her five engines giving 700 b.h.p each (the figure contemplated originally) 'R 101' could have developed a speed of 77 m p h,—which is slightly in excess of her estimated speed Recourse to the Servo-motor gear was not found necessary (if this holds good at full speed the gear may be removed, and then about ½ ton will be added to the useful 'lift'), and the stability of the ship was reported to be entirely satisfactory. Thus the trials, so far as they go, give no support to those critics who upbraided the temerity of our decision to recommend a shape considerably less elongated than those of past German airships. I have never been able to understand the reasoning which convinced them (quite independently of any question of 'scale-effect') that the new shapes must prove specially difficult to control; on the structural side it should be obvious that the hull (which is a girder, serving to transmit the concentrated loads of the passengers and engines) must benefit by being made relatively short and deep. Perhaps they failed to visualise the meaning of a 'fineness-ratio' of 5 5 · as Fig. 2 indicates, the shape of 'R 101' is short in comparison with earlier ships, but it is not appropriately described as 'plump'.

Space does not permit a description of the many ingenious devices which Col. Richmond, the chief designer, and his small band of assistants have incorporated in their design. The interested reader may be referred to the *Journal of the Royal Aeronautical Society*, August 1929, for a full description, and I must be content here to express the unqualified admiration I have learned to feel for their work—an admiration which will persist even if (as I do not expect) 'R 101' is ultimately pronounced to be a failure I turn now to the other side of the picture—the problems which still await solution.

The Achilles' heel of 'R 101', so far as it is possible to judge at present, is her power plant. No one is to blame for this circumstance, but it cannot be denied, and it is very serious Designed to carry five engines of 700 b.h.p., 'R 101' can at present count only on four, and these will not develop continuously more than about 600 b.h.p. each [2] So her designed power has been reduced by more than 30 per cent, and the 77 m p.h. which she should attain at full power is replaced by a figure slightly under 68: against a head wind of 60 m.p.h.

[2] See letter from the Editor of *Aircraft Engineering* in the *Times* of Oct. 23, and lecture on "The Machinery Installation of 'R 101'" (T. R. Cave-Browne-Cave) in the *Journal R Ae. Soc.*, March 1929.

she can make good only 8 ground miles per hour, instead of 17. Moreover, the engines are *heavy* They weigh 7 lb per h p. 'dry'—a figure about twice as high as that which Mr Chorlton, their designer, considers to be possible now, and was believed to be possible when the design of 'R 101' was started Five tons will be added to the useful load if and when these hopes are realised [3]

The 'troubles' which have led to this result were enumerated by Wing-Commander Cave-Browne-Cave in his lecture to the Royal Aeronautical Society. torsional resonance of the crankshafts (a fault which is difficult to remedy at a late stage in design) has necessitated increased weight and delayed the fitting of "variable pitch airscrews", the aluminium crankcases gave trouble (as origin-

In the original project. 'R 101' was planned to run on heavy fuel oil, using engines which were to be developed from a marine type weighing about 100 lb per b h p. The high flash-point of the fuel would eliminate the danger of fire occurring in tropical temperatures, greater distances could be flown on a given weight of fuel, and the cost of fuel would be largely reduced In 'R 100' the same objectives were to be attained by the use of engines burning a mixture of paraffin and hydrogen, —thus utilising gas which otherwise would be valved, and so wasted The latter engines have not materialised, and 'R 100' is, for the present, to burn petrol after all 'R 101', as we have seen, has attained her objective, but at a serious cost in loss of speed

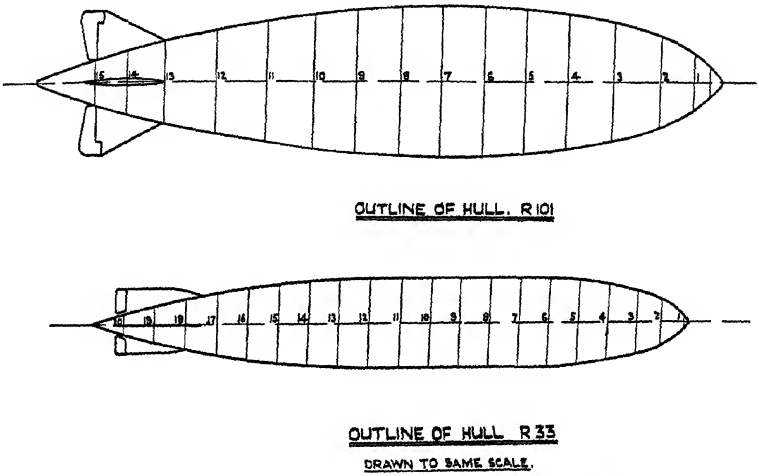


FIG 2.—Outlines of hull of 'R 101' and 'R 33'. Royal Air Force official Crown copyright reserved.

ally designed) and have been replaced by steel Wing-Commander Cave remarked that "none of the major troubles has been due to the engine working with heavy oil". In a strictly technical sense this statement is true, but in the wider aspect it may be misleading; for the decision to use heavy oil meant that special engines had to be designed *ab initio*, whereas, had petrol been the intended fuel, engines of tried reliability could have been incorporated.

Let me say at once that I consider the Air Ministry's decision, based on its determination to aim at 'safety first', to have been in every way right and wise. Airships in Great Britain have still to win public confidence, and a disaster sustained by either of the new ships would probably result again (as in 1921) in a total cessation of construction. The difficulty that has arisen is solely a matter of time *a new engine, working on a relatively novel principle, takes longer to perfect than an airship hull*

The consequence is that these two airships, originally intended to be exactly comparable and so to test the relative efficiency of 'official' and independent commercial design, are not directly comparable to all. 'R 100', with her six Rolls-Royce engines, can count on 4200 b h.p.,[4] but she cannot (according to the standards originally imposed) safely be flown in the tropics. 'R 101' is safe to fly as regards fire risk, but her depleted speed introduces an element of danger of another kind, and in really strong winds her captain will have anxieties for which her designer is in no way responsible. From the scientific point of view one must regret that she, too, has not been equipped to run on petrol, as a temporary expedient, until such time as her heavy-oil engines have been brought more closely into accord with their intended performance. A year spent in temperate climates—on flights planned with a view to the accurate measurement of speed, controllability, hull stresses and the like—would yield knowledge

[3] See Mr. Chorlton's letter in the *Times* of Oct 19.

[4] "The World, the Air and the Future" (Burney), p. 210.

of incalculable value regarding the merits of the new designs, and would enable the flights to Egypt and to India to be planned with greater confidence Both airships are experimental, and the experiment ought not to be hurried at any cost in added risk

As matters stand, comparison is still possible, but it must be made with care relative figures, if given without full explanation, may be entirely misleading Thus, in regard to speed, the measured performances of the two ships must be 'corrected' (according to the cube law which expresses the power-speed relation) in order that their hull resistances may be compared on a basis of equal power; the fact that they carry widely different power plants is (speaking scientifically) an irrelevant circumstance which this procedure will serve to eliminate Similar remarks apply to the question of useful lift, or 'pay load'; the heavier engines carried by 'R 101' must not be allowed to detract from our estimate of her structural design, nor from this point of view is she entitled to credit for the fact that 1 ton of heavy oil represents a wider radius of action than 1 ton of petrol *Either ship might have been fitted with either power plant*; therefore the hulls must be compared for efficiency, as engineering structures, on a basis of the total weight which they can carry, for the same quantity of hydrogen, in passengers, crew, furniture, engines, and fuel combined.

Finally, the comparison must be made on a basis of figures ascertained in actual flight, not on estimates How easily the latter may be in error is indicated by the remark that at least a ton of dust had settled on 'R 101' during her time of waiting in the shed.[5] Useful lift can be *estimated* only as a (relatively) small difference between two large quantities. when the hull is air-borne it can be *measured* with certainty. Estimates, it is safe to say, have been the curse of airships so hard to check, when airship flights are as infrequent as solar eclipses; so easily modified to suit the thesis of the moment, whether sanguine or condemnatory.

The enthusiast, whose millenium is always five years ahead, can seldom resist the temptation to detract from actual achievement, in order that the advantages of his new project may be displayed in stronger light, he forgets that it is only on achievement that the outside world, with sound instinct, will base its expectations and its support of airships. To those who have the progress of airships most at heart, it is a relief to pass from a period of words and 'estimates' to a period in which the new ships must stand their trial Very soon now we shall know with certainty the relative merits of 'R 100' and 'R 101', and how they compare with the airships of other countries, then, but not until then, can future projects be based on sure foundations

[5] *Times* of Oct 14

## The British Association in South and East Africa.[1]

By Sir RICHARD GREGORY.

WHEN the Prince of Wales was president of the British Association at the Oxford meeting in 1926, he made particular reference in his address to the value of meetings of the Association overseas in creating interest in science and co-ordinating the work and results of scientific investigators throughout the Empire. "Nothing but good", he remarked, "can follow from personal contact between scientific workers in different parts of the Empire Nothing but good can follow from their researches if they add, as gradually they must add, to the wider knowledge of the Empire not only among the workers themselves, but ultimately among the whole body of informed Imperial citizenship; not only in the overseas territories, but also at home."

As one of the main functions of the British Association is to bring home to the public the significance and value of science to human life, nothing now would seem more natural than to extend these activities occasionally to fields of the Empire overseas and not to confine meetings to the British Isles. More than half a century elapsed, however, from the foundation of the Association before the first overseas meeting was held at Montreal in 1884. Since then meetings have been held twice in South Africa, once in Australia, and in Canada again in 1897 and 1909, and every meeting has had very decided influence in stimulating scientific work in the country visited as well as engaging the interest of the visitors in the solution of new problems. There is no longer any doubt as to the importance of acquiring first-hand knowledge of our overseas territories, or need to emphasise the good that results from personal contact between workers in various parts of the Empire. Co-operation and co-ordination are essential to avoid waste of effort and secure rationalisation in science, and the British Association is greatly assisting progress towards this end by its overseas meetings.

The world has to look to tropical agriculture for a large part of its food supply and raw materials in the future, and to ensure that this will be forthcoming it is essential that the fullest scientific knowledge should be available and used to protect crops from the pests which continually assail them in tropical countries. In Africa in particular, the facts to be faced and the problems to be solved are set forth most convincingly in the Report of the Parliamentary Commission of Inquiry to East Africa in 1924 and in Mr. Ormsby-Gore's report on the four British West African territories in 1926. One of the most gratifying features of the former report was the recognition of the economic value of scientific guidance to such countries. Mr. Ormsby-Gore was chairman of the East African Commission, and he had the advantage of

[1] From an address on "Science and the Empire" given on Dec. 3 at a meeting of the Royal Empire Society in co-operation with the British Association, following upon the recent meeting of the Association in South Africa.

operation with a scientific colleague, Major A. G. Church, secretary of the Association of Scientific Workers. The two reports emphasise the urgent necessity for applying the methods and results of science to the problems of tropical development, both in administration and production.

The meetings at Cape Town and Johannesburg afforded an opportunity for comparative study of man in Africa and Europe, and resulted in valuable discussions on material archæology and physical anthropology of Africa. The resemblance of the Stellenbosch type of stone implement to the Acheulean type in south-west Europe, of the majority of the rock paintings in South Africa to those of eastern Spain, and of skulls like those recently obtained by Mr. Leakey in Kenya, approaching the European in type, suggest that early man reached Europe from Africa. Though the peoples represented by these cultures and characteristics may have had some part of Asia as their primeval home, there is evidence that north Africa or south-west Asia was at any rate a secondary centre from which they diverged to south-west Europe, to south India, and to equatorial and south Africa. The continuation of Mr. Leakey's work promises to lead to new interpretations of movements of early culture in Africa, and may throw light on the evolution of modern African types of man. There is urgent need for support on a large scale for research of this kind, and investigations into related ethnographical problems in Kenya and the rest of East Africa. If a generous benefactor could be found to endow an anthropological research institute in East Africa, a very valuable service would be rendered to mankind as well as to the British Empire.

Of the value, and indeed the necessity, of a practical application of the science of anthropology in native administration there can be no question. Without anthropological knowledge it is impossible to predict what will be the effect of interference with any native custom, even though on one hand it may seem repugnant to European ideas, or on the other of so trivial a character that its repression may seem a matter of no importance. Anthropology, studying each custom and each belief as it functions in a given social environment, traces it through its various ramifications in the whole cultural complex, and is thus able to show the consequences throughout the whole social fabric when any attempt is made to modify or suppress that particular custom. The attempt to advance the status of native women in South Africa by abolishing the 'bride price' failed through misunderstanding and imperfect knowledge of the facts. Until the custom was reinstated there was no stability in family or tribal life. Another example of a measure introduced with the best of intentions and having only the well-being of the native in view, but which failed through lack of knowledge, is afforded by the order issued in one of our dependencies to destroy all rats with the object of stamping out plague. To carry out this order effectively the roofs of native huts had to be taken off. To the surprise of the officials of the health service, this was the cause of great resentment among the natives. On inquiry, however, it was found that as a matter of religious custom the unroofing and re-roofing of each hut made the sacrifice of a goat incumbent upon the owner. A knowledge of anthropology would have averted the creation of what might have been a serious situation. It must indeed be understood that the development of a backward people along natural lines demands from an administrator an intensive study of their customs, their religions and modes of thought, guided by a training in the methods of anthropological science.

Another aspect of the 'native problem' is that of agricultural development. South African agriculture is essentially based upon unlimited supplies of cheap native labour, and the implements and methods, for example, bullock waggons for transport, reflect this condition. In a sense, the period of development corresponds to British agriculture in the middle of the eighteenth century, but superimposed on this are the resources of modern agricultural science through the introduction of new varieties, animal breeding, marketing, and cold storage facilities, and these have enabled it to carry on and even to develop an export trade. If the native problem becomes more acute, and a higher standard of living leads to demands for higher wages, it will necessitate a complete reorganisation of South African farming. The great difficulty of running a farm successfully at present, except in a few favoured spots, is due almost entirely to climatic conditions, or in other words, the supply of water. This involves the problem of irrigation; and here it may be said incidentally that the excellent soil survey work that is being carried on has provided the irrigation department with most valuable information upon which to base irrigation projects. As irrigation is costly, only luxury crops can be grown in such districts with hope of financial success; hence the concentration on citrus fruits. It is improbable, however, that South Africa can ever export enough to control our markets, and attention should therefore be devoted to high-grade supplies, which means drastic grading of fruit prior to export. The wine industry is most promising, and the Empire Marketing Board should do more to make its products better known in Great Britain.

The afforestation schemes in different parts of South Africa, and the rapid development of sugarcane and wattle growing in Natal, are particularly noteworthy. As the recent debate in the House of Commons showed, one of the subjects with which almost every country is at present preoccupied is the question of the future supplies of softwood timber, and foresters are in consequence interested in all efforts to increase softwood production. In South Africa the percentage of land under forest is very low, and the indigenous softwoods, although they produce good timber, are slow growing, and difficult to establish on the veld, hence of little value in the extension of forest area. South African foresters, however, have shown enterprise in seeking for tree species which will grow well

under the various conditions in their country, and from the large number which they have tried, they are now carrying out extensive afforestation with pines from the Monterey Peninsula in California, the Mediterranean Basin, the slopes of the Himalaya Mountains, the Canary Islands, Mexico, and Central America For hardwood production Australian species, particularly *Eucalyptus*, are being used. The results of this work will be of assistance to foresters who have to deal with similar conditions in different parts of the Empire, and the publication of the papers prepared by the South African foresters for the British Association meeting will disseminate the knowledge so far obtained This experiment on the creation of an entirely new forest complex raises forest problems of great diversity and interest in soil biology, pathology, and methods of tending the plantations, and the discussions between the European and South African foresters resulted in the pooling of the knowledge at present available, and suggested lines for future investigation

Farther north, for example in Northern Rhodesia, forestry is only beginning to be developed. The first step is the survey and stock-taking of the indigenous forest resources, and this necessitates the identification of the many different tree species. Even in a country such as Nyasaland, where a forestry service has been developed for some time, owing to pressure of administrative duties, work of this kind remains to be done Assistance in both colonies was given by a systematic botanist, Dr. J Burtt Davy, during his visit to Africa

In both South and East Africa the crying need of the moment is for workers to name the plants The visitors were told in South Africa, and the same thing is true of East Africa, that if a botanist set to work on any square mile of the country, probably he would find at least one new flowering plant that had no name, and probably more than one. Certainly it is true that whatever interests the botanist may start with when he leaves the mother country for Africa, he is soon driven by circumstances to turn aside from a primarily physiological or other inquiry in order to ascertain what is the correct name of the plant with which he is working. This is the first need on the scientific side, but it is also true on the practical side. It is of prime importance in relation to problems in regard to poisoning of stock Veterinary officers in Northern Rhodesia took visitors to districts and pointed out probably the plant itself, certainly the group of plants, which are responsible for producing certain symptoms in the stock grazing in that area. This they have been able to do for several years past, but they were still unable to give a name to the plant that is the cause of their trouble, and as a consequence they are no nearer an understanding of the means of eradicating the trouble, and they have no idea of the extent of the plant's distribution, its season, etc. One of the crying needs of the botanical side is more help on the systematic side.

One thing that the home botanists ought to do, therefore, is to supply the workers in this systematic field in the new country. Africa with its own active university departments, all of which have heads alive to the botanic needs of the country, will soon supply its own workers in this field At present it needs the resources, however, of the old country As a matter of fact, one of the ironies of the situation is that as nearly all the original work upon the Cape flora has been done by European botanists, the only places where the African plants can be named with certainty at present is in the home country in touch with the big British and European herbaria There is, quite possibly, room for a greater development of systematic work on this type of plant material in connexion with Kew or with the Natural History Museum at South Kensington

There are thirteen separate sections of the British Association concerned with different departments of science, and each of these held meetings at Cape Town and Johannesburg Mr O J R. Howarth, secretary of the Association, has been good enough to furnish me with the following summary of the scientific programme of the meetings:

"In Cape Town and Johannesburg there were some 350 addresses, lectures, papers, and discussions in all. Of these, fully one-third were on specifically South African topics, and many of them were contributed by South African scientific workers. To mention only a few as examples—the chemists dealt with essential oils from South African plants, with recently discovered nitrate deposits in South-West Africa, and with the chemistry of gold extraction. The geologists were concerned in very large measure with the geology of the sub-continent they not only heard papers on it, but studied it widely in the field, co-operating with the International Geological Congress (which coincided with our own meeting) in order to do so Geologists, zoologists, and botanists combined to discuss the debatable subject of the lost continent of Gondwanaland.

"A large part of the zoological and botanical programmes had a definitely South African bias, and both sections benefited by exhibits and demonstrations arranged for the instruction of the visitors. The discussion organised by the Sections of Zoology, Botany, and Physiology on 'The Nature of Life' was opened by our most distinguished South African member, General Smuts. The Section of Geography, under the presidency of the Director-General of the Ordnance Survey, Brigadier Jack, devoted an important part of its programme to the progress of surveying and cartography in South Africa; and it studied a whole series of aspects of human environment, such as the effects of relief of the land upon settlement, economic development under desert conditions, water-supply, soils, and so forth It also joined the Section of Education in discussing the teaching of geography, with special reference to South African schools and universities.

"The Economics and Anthropological Sections united to consider economic competition between advanced and backward peoples, and covered a wide field of South African economic problems. The Engineering Section dealt appropriately with

refrigeration, road and rail transport, town planning, irrigation, and mining machinery The Anthropological Section, it need scarcely be said, was in its element chief among many features of topical interest it received Miss Caton-Thompson's report upon her excavations at Zimbabwe and other sites in Southern Rhodesia, carried out at the instance of the Association, and confirming the medieval origin of the buildings in the face of romantic ideas as to their much greater age The physiologists and engineers jointly considered problems connected with the ventilation of deep mines on the Rand and elsewhere The psychologists contributed their results associated with some of the population problems of South Africa The Educational Section devoted itself almost wholly to South African topics · and lastly, the Agricultural Section had the unique opportunity of meeting jointly, in Pretoria, with the Pan-African Agricultural and Veterinary Congress."

There can be no question as to the stimulus which consideration of these and other subjects has given to science in South Africa, or in the interest which has been created among the visitors in the scientific and economic problems of the country Everywhere the scientific staffs, research workers, and planters were eager to get into touch with visitors possessing intimate knowledge of their subjects, and to seek advice as to deductions to be drawn from work in South Africa or suggestions for further activities The foregoing general survey represents not only personal conclusions as to the place of science in the development of the Empire, but also the views of competent authorities upon specific problems in South and East Africa Among those with whom I have had conversations or correspondence, and to whom I am indebted for information, are Prof H J. Fleure, Mr E N Fallaize, Dr B A Keen, Dr H M Steven, and Prof J H Priestley We all aim to advance progress and promote human welfare, and many of us are convinced that this can be attained only by scientific guidance Upon statesmen and administrators is the responsibility of seeing that this guidance is rightly regarded and effectively used

## Obituary.

### DR. J. C MELVILL

DR. JAMES COSMO MELVILL, of Meole Brace Hall, Shrewsbury, well known as a conchologist and botanist, who died on Nov. 4, was born in London on July 1, 1845, and was the son of James Cosmo Melvill, Under-Secretary of State for India, and the grandson of Sir James Cosmo Melvill, F R.S., chief secretary of the East India Company. He was educated at Harrow and Trinity College, Cambridge, and entered the business of his uncle, Edward Hardcastle, travelling in North America, where he had opportunities for studying natural history and making collections. He later joined the firm of Messrs. G. and R. Dewhurst, of Manchester and Preston, serving as a director for many years.

While at Harrow Dr. Melvill published, in conjunction with the Hon. F. Bridgeman, "The Flora of Harrow". In later years he accumulated and arranged three-quarters of the known plants of the world. The greater part of this fine herbarium, containing many valuable plants and including some obtained by Charles Darwin during the voyage of the *Beagle*, was presented to the Manchester Museum in 1904 The remainder, which consist of the grasses and ferns of the world, together with about a third of the known seaweeds, will shortly be added to the others at Manchester.

Dr Melvill began to collect shells at the early age of eight, and during his lifetime this collection grew to be the largest known in private hands, comprising 22,500 species. He described more than 1000 new species of mollusca, by himself or in collaboration with others, including the late Robert Standen. His conchological contributions are very numerous, and comprise descriptions of species from South Africa, the Persian Gulf, the Arctic and Antarctic regions. He joined the Conchological Society in 1880, and was president in 1889 and again in 1895–96, on each occasion delivering an excellent address. He was an original member of the Malacological Society (founded in 1893) and was its president at the time of his death.

In addition to botany and conchology, Dr. Melvill took a keen interest in British insects and made quite a large collection. He was a member of the Linnean, the Zoological, the Entomological, and the Manchester Literary and Philosophical Societies, being president of the last in 1897–99. For many years he was on the Court of Governors and the Council of the University of Manchester. He was a member of the Manchester Museum Committee, being chairman for several years. During his residence at Meole Brace Hall, he was honorary curator of the Shrewsbury Museum and served as president of the Caradoc Field Club.

An all-round naturalist, Dr. Melvill's knowledge of the mollusca was masterly, and on the occasion of the Victoria University conferring upon him the D Sc., Prof Lamb remarked: "It is chronicled of Solomon that he spake of trees, from the cedar that is of Lebanon, unto the hyssop that springeth out of the wall, but it is not recorded that he also knew by heart all the shells from the Arctic Circle to the Persian Gulf. That double weight of learning was reserved for the accomplished systematist, Mr. Cosmo Melvill, and those who know him will testify with what gracious modesty he sustains it"

J. WILFRID JACKSON.

WE regret to announce the following deaths:

The Hon. Sir John Cockburn, K.C.M.G., president of the Child Study Society, who was premier chief secretary in 1889–90 of South Australia, on Nov. 26, aged seventy-nine years.

Mr. Francis A. J. Fitzgerald, head of the Fitzgerald Laboratories, Niagara Falls, and president in 1916 of the American Electro-Chemical Society, on Oct. 26, aged fifty-nine years.

## News and Views.

JEAN BAPTISTE PIERRE LAMARCK died one hundred years ago, on Dec. 18, in his eighty sixth year—a master of zoology whose work and thoughts gave fresh impetus to the progress of biology in his day, and in ours still enliven the unsettled controversy concerning the heritability of 'acquired' characters. Lamarck was a systematist, and in these days when systematics is apt to be despised among the multiplying branches of zoology, it is well to be reminded that it was on his experience in the discrimination of species that his great achievements were based. The earliest of these bore upon the classification of animals. He investigated the rich fauna of fossil mollusca in the Tertiary beds of the Paris basin, discovered that different species were distinctive of different beds, and gave at once an auspicious start to the palæontology of invertebrates and a lusty push to the stratigraphical conception of geological formations which his contemporary Werner had inaugurated. For the first time, he proposed a reasonable division and grouping of the invertebrate animals, which, apart from the insects, Linnæus had bundled into a hotchpotch of 'Vermes'. It was characteristic of Lamarck that his mind kept revolving the greater problems raised by his detailed work. Thus the satisfaction with which he at first regarded the linear arrangement of his classification of the animal world gave way to doubt, and ultimately was replaced by the modern conception of a branching genealogical tree—a change of view which says much for the openness of the naturalist's mind at an age at which professors are nowadays compelled to retire.

EVOLUTION was in the air during the latter half of Lamarck's life, and close reasoning, founded upon a grasp of systematic detail and sequence, enabled him to make a notable advance. He thought that changing environment influenced the habits of animals as changing wants might influence habits, and new habits meant the adaptation of old structures. The crux of his position lay in his assumption that adaptations thus acquired by an individual became, without more ado, part of the stock-in-trade of its progeny. No theory has swung more completely between the poles of belief and unbelief than Lamarck's assumption of the heritability of 'acquired' characters. At the first it was assumed without proof, and was held for years as being self-evident. Weissmann gave it a blow from which it has not yet recovered, and, for years after Weissmann's analysis of the 'eighties, few zoologists of standing but regarded the transmission of acquired characters as being not only unproved but also theoretically impossible. Fortunately, modern views are more elastic, and Lamarckism in a modified form has again its supporters amongst zoologists as well as botanists.

THE gale that set in over the south-west of England on the night of Dec. 6 last rose to hurricane strength in the early hours of Dec. 7, and a gust of 108 miles an hour was recorded. Much damage is reported both to shipping and also inland. It bore a striking resemblance to the storm of Mar. 8, 1922, which also gave a gust of 108 miles an hour and reached its climax at about the same hour of the morning. Slightly higher speeds have been recorded in other parts of the British Isles: 109 miles an hour at Dunfanaghy (Donegal) on Jan. 28, 1927, and 110 miles an hour at Quilty (Co. Clare) on Jan. 27, 1920. The gale of Jan. 28, 1927, was in many respects the most remarkable of the four, in that it yielded gusts of more than 100 miles an hour, not only in Ireland but also in Scotland, and the average speed actually exceeded 80 miles an hour for a time at Dunfanaghy. Winds of this strength are very rare outside tropical hurricanes and tornadoes. One might be tempted to regard them as very nearly the extreme limit of what can be achieved by a fast-moving secondary depression, in which the air motion can often be resolved into a more or less complete circular whirl and a motion of translation, generally from west or south-west, the resultant wind being very strong where the two components are in the same direction, that is to the south or south-west of the centre. But it is doubtful whether this is the case. Sir Napier Shaw, in his well-known work on weather forecasting, mentions a gale associated with just such a fast-moving secondary that blew down hundreds of trees in Cambridge between 2 P.M. and 4 P.M. on Mar. 24, 1895. This gale may be within the recollection of some of our readers. It was doubtless considerably more severe than the recent gale, and equally destructive storms have been recorded.

THE Barton power station of the Manchester Corporation and the proposed Battersea power station of the London Power Company are good illustrations of the difficulties inherent in working large steam stations, some of which electrical engineers and chemists are now successfully overcoming. The Manchester station is attacked because it is located in open country and the fumes emitted were deleterious to vegetation. The Battersea power station is to be built in urban surroundings and near important public buildings. By appealing against the injunction made against it by the Court of Appeal, the Manchester Corporation has gained a year during which it must abate the nuisance. The successful experiments carried out at the Grove Road Station showing how sulphur fumes can be eliminated from flue gases are very promising. According to a White Paper issued by the Ministry of Transport (Cmd. 3442, London: H.M. Stationery Office, 6d.), the Government Committee states that the possibility of eliminating nearly the whole of the sulphur gas present in the fumes has been proved. It desires, however, that a more definite explanation of the mechanism of the oxidation of sulphurous to sulphuric acid should be forthcoming before it can report on the practicability of the process. We are surprised that the opponents of the Battersea power station do not suggest some other site and give figures to prove that it is practicable. The problem of supplying London with electricity is not an easy one. The demand now exceeds 400,000 kilowatts, the capital involved is very large

the prosperity of many industries depends on cheap electric power, and the comfort of hundreds of thousands of citizens is involved Purely destructive criticism is not helpful. It is easy to put spokes in the wheel of progress. Our sympathies are entirely with those chemists and engineers who are doing their best to mitigate the objectionable components present in the fumes arising from the combustion of fuel

AT a meeting of the Royal Anthropological Institute on Dec. 3. Mr. A. Leslie Armstrong described an archæological expedition undertaken this year with the object of exploring caves in Rhodesia, and in view of the meeting of the British Association in South Africa The cave of Bambata is situated near the summit of the mountain of that name, the highest in a group of typical granite hills lying on the south east verge of the Motopo Hills. Through the work of the Rev Neville Jones of Hope Fountain, and Dr. Arnold of Bulawayo, in 1918, the cave was known to contain important deposits and a frieze of wall paintings. Work was commenced here by the expedition early in June. The relic bed proved to be nearly 20 feet in thickness, and provided for the first time in South Africa a definitely stratified sequence of cultures. At the base was a Lower Palæolithic stratum, more than three feet in thickness, containing *coup de poing* of South African Acheulean (Stellenbosch) facies This was succeeded by a deep deposit of typical Mousterian character, above which, through a thickness of more than twelve feet, was a distinctive culture exhibiting Capsian affinities, but with Mousterian tendencies or survivals. Burins were abundant in this culture, also a distinctive point, the gradual development of which was traced from a pure Mousterian point, by well-defined stages, into a slender point of almost Solutrean technique. The upper layer of the deposit contained implements of microlithic form which are apparently ancestral to the Wilton culture of the Cape. The Mousterian zone was found to include definite intercalations of Capsian layers, separated and covered by layers of normal Mousterian character. This suggests the contemporary presence in this area of the two races before the Neoanthropic influence became dominant. At the Victoria Falls it was possible to correlate the Lower Palæolithic cultures contained in the residual gravels of the Zambezi River, with definite stages in the cutting back of the river gorge. The results demonstrate the great antiquity of Palæolithic man in South Africa.

STUDENTS of psychic phenomena will find much to interest them in an article entitled " Spirit Hunting in the South Seas ", which is contributed by Prof. B. Malinowski to the *Realist* for December. In it he describes a manifestation by Tomwaya Lakwabula, a famous spirit-seer of the village of Oburaku in the Trobriand Islands of Melanesia, which came under his personal observation. It has always been a question how far the medicine man or shaman has availed himself of imposture in the manifestation of his powers or how far they were due to the effects of hysteria, autohypnosis, or some similar abnormal psychic state. It is evident that Prof. Malinowski is something of a sceptic, at least in regard to certain points in the medium's operations. It would appear that there are two classes of seers A minor class, and even this is not indeed numerous, visits the spirit world for short periods and receives visits from the spirits, who bring messages and foretell the future. The second class consists of the great seers who occur but rarely in the history of the people. This latter class falls into prolonged trances, not in secret as among the first class, but in the eyes of the multitude It was one of these prolonged trances which came under Prof Malinowski's observation, lasting for more than a week. The call to this trance comes, the natives believe, from the spirits themselves.

THE first manifestation of the spirit seer's powers which Prof Malinowski saw was at the mortuary wake of the chief, when after the nervous twitchings usual in such cases, the seer broke into song in a voice which was not his own but was recognised by the natives as that of the chief, and in a language which was not that of the natives, but was said to be of the spirit world. Immediately afterwards the poles and platform at the grave were violently disturbed. This, it was said, was caused by the spirit of the chief trying to return to the body. During the prolonged trance, seances were held nightly, when the villagers gathered round the hut in which the medium's body lay extended on a couch visible from the door, and attended by his daughter. Although the seer at these seances sang both in his own and in an altered voice—on one occasion there were at least two changes, and once there took place the materialisation of a small bunch of betel nuts—no messages were delivered until the sixth or seventh night. These messages dealt with practical affairs—the disposal of a canoe, the arrangements for the periodical ceremonial feast to be celebrated in memory of the deceased chief, and so forth. The voice in which these messages were delivered was not that of the chief, but of a man who was said to have been dead for some time. When the trance was over the seer appeared to be much emaciated, perhaps only natural as his food had been supplied by the spirit world, though Prof. Malinowski has his doubts on this point. He looked tired, and his mind at first seemed quite vacant; only slowly did his mental faculties return to normal. The whole account is extremely interesting, and although the very practical and apposite character of the messages from the spirit world arouses some suspicion, it seems a genuine case of an abnormal personality, possibly exploited with some skill.

THE undoubted power of the cinema as an influence in education has not, as yet, been harnessed in Great Britain. Other countries, notably Russia, Germany, France, and the United States, have elaborated formulæ for the employment of the motion picture; but we have lagged behind. Considerable expectations are, therefore, to be attached to the work of a commission of inquiry appointed by a conference of scientific and educational societies and institutions which was held on Nov. 27. In April of this year the Association of Scientific Workers took the lead by calling a preliminary conference, which appointed an organising committee. This committee acted in conjunction with the British Institute for Adult Education in drafting the report to

be presented and in calling the second conference. The report proposed the formation of a representative commission and defined its terms of reference with such breadth as to include an inquiry into the various aspects of mechanical visual and aural aids in education, films in relation to the general education and culture of the public, and the establishment of a central organisation to co-ordinate work, both research and informatory, on the motion picture in relation to general and specialist education. The constitution of the commission insures that its findings will be received with respect The members include Prof. W. A. R. Ainsworth, who represents the Board of Education; Mr. J. W. Brown, Mr A. C. Cameron; Major A. G. Church; Mr. E. Salter Davis; Mr. J. Fairgrieve; Sir Richard Gregory, Sir Benjamin Gott, Mr G. T. Hankin, Mr F. A. Hoare; Sir Percy Jackson, Dr C. W Kimmins; Colonel J. M. Mitchell; Prof. J. L. Myers, and it has power to co opt additional members.

MR. ALAN E. MUNBY read a paper to the Royal Institute of British Architects on Nov. 18, on the design of science buildings. He made a strong plea for greater efficiency in building, and pointed out that a little extra expenditure often meant a disproportionately great increase in technical completeness. One of the great difficulties of the architect lies in the absence of any consensus of opinion on the part of educationists and men of science as to the appropriate equipment for specific subjects, and Mr. Munby suggested that some generally agreed outline of requirements might be formulated without undue difficulty As to the buildings themselves, the adoption of a unit will often simplify construction and assist in the allocation of space, but the architect must constantly bear in mind that the whole design must grow up together, and that the fixed fittings must be laid out on the plans, suitably spaced, at a stage to prevent the embarrassment of the general contractor by subsequent changes. After a consideration of the chief technical details, Mr. Munby stressed the importance an architect should attach to acquiring a thorough understanding of the highly specialised objects aimed at; only so can he be in a position to deal intelligently with the various schedules of requirements that may be placed before him and to give them proper amplification in detail. Otherwise, we feel that sympathy would certainly be due to the professor who told Mr. Munby that he would much rather have an architect who knew nothing about science buildings than one who thought he knew something.

THE Annual Forest Report for Finland, 1927, recently published, depicts the wonderful progress which has been achieved in the introduction of a scientific management into the forests in the ten years since she established her independence during the period of the Kerensky Government in Russia in 1917. Apart from the notable position Finnish timbers have obtained in the European soft wood export trade (she exported 1,283,000 standards of sawn material during the year), there are other important directions in which Finland has been dealing with the forestry question from the point of view of the economic necessities of the country as a whole. Finland is mainly a forest country; out of a total superficial area of 14,151,052 hectares, the forest and waste lands cover 13,449,387 hectares. Any effective administration of the country must therefore inevitably be intimately bound up with a proper management of the forests. That this fact has been thoroughly appreciated the Report well displays. Laws have been introduced which afford protection to areas both in the north and on the seaboard and the islands, where disafforestation would lead either to denudation of mountain slopes or to the serious results of exposure to wind and storms.

THE question of the management in Finland of communal forests (namely, areas owned collectively by villages, etc ), and of those belonging to the Church and other bodies, has been met by placing the management in its main principles under the Forest Department Another law has enabled the latter to maintain supervision over privately owned forests. The owners are not permitted to exploit their forests without making arrangements for re-stocking the areas felled; the extent of the fellings made in any one area is also limited by sylvicultural principles. Commissions in each district, consisting of forest officials, are responsible for the supervision, and purchasers of the materials to be felled on areas they buy have to submit to the Commissions an estimate of the amount of material they expect to fell. Thus a check has been instituted against over-felling on one hand, and on the other against leaving unregenerated a felled area. It is said that the private proprietors realise to the full the importance of this law and have readily fallen in with its requirements. Four forest schools are maintained and a research institute. The work undertaken by the professors and assistants in the latter is already becoming well known and will achieve results of lasting importance to Finland. It is a wonderful record for ten years.

THE brilliant success of the Deutsches Museum in Munich, in pushing to its furthest limits the use of motion in adding to the attractiveness of exhibits, has suggested similar developments in other countries. The latest project of the kind is a great scheme for a Museum of Science and Industry in Chicago to "reveal the technical ascent of man". According to Science Service, Washington, D.C., it is proposed to build in Jackson Park a replica in stone of the old Fine Arts building of the World's Exposition of 1893, which is still standing. The new building will cost 5,000,000 dollars, will be fitted for the exhibition of technical and scientific collections, and will possess about 400,000 square feet of floor area. Mr Julius Rosenwald has endowed the Museum with 3,000,000 dollars, to be spent on exhibits and equipment, but it is surmised that, as in Bavaria, municipalities, the great industries, and private individuals will hasten to add to the completeness of the stock-in-trade of the Museum. Work is to proceed at once, and by 1933 the building ought to be completed and open to the public, although the wise decision has been taken that no attempt will be made to rush the collection and arrangement of exhibits. If the Deutsches

Museum be taken as a standard, the collections may ultimately be worth some 30,000,000 dollars

THE Report of the meetings of the International Commission on Illumination, held in the United States in September 1928, is a volume of nearly 1300 pages with 18 pages of index The subjects discussed included street lighting, glare, car headlights, daylight and artificial illumination of works and schools, standards, methods and appliances for photometry, diffusing and signal glasses, colorimetry, vocabulary, units and symbols The principal decisions are given on pp 9–20, and some of them are subject to further consideration after reports from the various national committees The vocabulary is fixed so far as French and English are concerned, but the German, Italian, and Spanish terms have still to be determined The c g s units are to be used; symbols are to be $F$, luminous flux, $I$, luminous intensity or candle power; $E$, illumination, $B$, brightness, $R$, luminous radiance, and $L$, quantity of light. The Geneva code for interior illumination is to be retained for the present and statistics for street lighting by modern methods are to be compiled. The proper method of specifying a coloured glass or a diffusing material is indicated, and plans outlined for setting colorimetry on an international scientific basis.

THE Multiple Industrial Fellowship on Portland Cement of the Mellon Institute of Industrial Research and the Eastern Face Brick Manufacturers' Association have recently inaugurated a broad scientific study of the problems of bricklaying So many factors are involved in the construction of a brick wall that it is necessary to limit the investigation to combinations of variables most likely to occur in actual practice. The project has been under discussion for a considerable period of time, experiments were begun by Dr. F. O Anderegg, senior industrial fellow at the Mellon Institute, and his assistants only after a satisfactory programme had been worked out. At the present time more than three hundred experimental brick walls or panels have been erected in order to find the most suitable combinations of materials and workmanship. The following problems are being investigated the rate of absorption and total absorption of moisture by brick; the surface characters of brick, the merits of different cementing materials, ranging from pure lime to pure cement, and of various sands and mortar pigments; the effect of varying the type of backing, both as to material and size of unit; the results of variation in workmanship, including pointing, tapping, and the filling of head-joints; the effect of variation in design, involving a study of coping and parapet construction, of capillary contact, of condensation, and of elasticity; and the behaviour of mortar with reference to the other variables in all types of climatic conditions. All results of these studies are to be published for the benefit of those interested in building construction.

WE record the foundation of a new scientific society, the Gesellschaft für Völkerkunde, which was formally constituted on Oct 1 with a hundred and sixty members Though organised on a German-speaking basis, its membership is open to ethnologists of all nationalities There is an entrance fee of 3 marks and an annual subscription of 5 marks for 1929, and of 3 marks for subsequent years. A quarterly journal entitled *Ethnologische Studien*, of which the first (a double number) has already appeared, is published on behalf of the Society by the Verlag Asia Major, under the editorship of Prof Fritz Krause, Director of the Ethnological Museum at Leipzig and the first president of the Society The journal will include ethnological papers in German, English, and French. Members have the privilege of obtaining the journal as well as the *Ethnologische Anzeiger* and *Anthropos* at a reduced price. The address of the Society is, Museum fur Volkerkunde, Johannisplatz, Leipzig, C 1. Further particulars may also be obtained from J. H Driberg, 8 Tavistock Place, W C.1.

IN the autumn issue of the *Fight against Disease*, the quarterly journal of the Research Defence Society, it is announced that a committee has been formed, with Lord Dawson of Penn as chairman, to perpetuate the memory of Henry Hill Hickman, who died in 1830, and was the first to suggest the use of oral inhalation for the production of anæsthesia during operations. This committee has received sufficient support to enable it to restore Hickman's tombstone and to place a memorial tablet in his native church of Bromfield, Shropshire. It is also hoped to be able to present his portrait to the Royal Society of Medicine and to establish a Hickman memorial medal for work of merit in anæsthesia. Donations may be sent to Dr. Cecil Hughes, 8 Cumberland Mansions, W.1.

THE July number of the *Transactions* of the Mining and Geological Institute of India contains the address of the newly elected president, Mr. F L. G. Simpson, which was devoted to a review of the mineral production of India for the forty-five years from 1880 compared with that of the rest of the world, the detailed figures upon which his statements were based being given in a series of tables appended to the address. He shows, for example, that within the period named, the weight of coal produced in India has been increased twenty-one times, whereas in Great Britain during the same period it has only been doubled, and in the whole of the rest of the world has been increased three times The tables referred to form a convenient summary of the mineral production of India over the period with which Mr. Simpson dealt

THE Right Hon Lord Cornwallis, chairman of the Kent County Council, has consented to act as president of the forty-first Congress and Health Exhibition of the Royal Sanitary Institute, to be held at Margate on June 21–28, 1930, and the following as presidents of sections: Dr. Andrew Balfour, Section A. (preventive medicine); Sir Henry Maybury, Section B (engineering and architecture); Lady Howard de Walden, Section C. (maternity and child welfare, including school hygiene); Sir John Moore, Section F. (veterinary hygiene).

MESSRS. Henry Sotheran, Ltd., 43 Piccadilly, W.1, have just circulated another part of their well known "Price Current of Literature". Its number is 816, and, as usual, it contains very valuable bibliographic notes with reference to many of the works listed. The catalogue is in the front rank of those which reach us, and should certainly be seen by collectors and librarians. The present part gives particulars of nearly 3000 books relating to mathematics, astronomy, physics, and philosophy, including the famous Newton Library.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A technical assistant in the testing department of an Admiralty establishment at Portsmouth—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (Dec. 17). A junior engineering assistant under the Corporation of Kingston upon Hull—The City Engineer, Guildhall, Hull (Dec. 18). An assistant pathologist for work in connexion with the radium 'bomb' treatment of cancer at the Westminster Hospital—The Secretary, Westminster Hospital, Broad Sanctuary, S.W.1 (Dec. 21). A pathologist and bacteriologist at the Cumberland Infirmary, Carlisle—The Secretary, Cumberland Infirmary, Carlisle (Dec. 31). A research fellow in the Department of Glass Technology of the University of Sheffield—The Registrar, The University, Sheffield (Dec. 31). A junior scientific officer in the Air Ministry's Scientific Research Pool, primarily for work at the Royal Aircraft Establishment—The Chief Superintendent, R.A.E., South Farnborough, Hants (Jan. 1, quoting A. 397). A lecturer and organiser in horticulture in the Department of Agriculture, the University, Leeds—The Registrar, The University, Leeds (Jan. 6). A director of the Apia Observatory—The High Commissioner for New Zealand, 415 Strand, W.C.2 (Jan. 25). A chief agricultural officer in Sind, under the Director of Agriculture, Bombay Presidency—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Jan. 31). A whole-time secretary to the School of Oriental Studies—The Director, School of Oriental Studies, Finsbury Circus, E.C.2 (Mar. 10). A junior assistant under the Directorate of Ballistics Research of the Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18. An assistant agricultural officer under the Kent Agricultural Committee—The Chief Agricultural Officer, Sessions House, Maidstone. A scientific assistant at the Imperial Bureau of Plant Genetics—The Director, Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge.

## Our Astronomical Column.

**Recent Fireballs.**—Mr. W. F. Denning writes: "On the first few nights of the present month brilliant meteors were unusually abundant, and several of them were of startling lustre though without detonations. On Dec. 2 at about 6 P.M. a fireball gave a brilliant display over the south of England. Another followed about four hours later, and a third, which lit up the whole countryside, blazed out just as the morning twilight came on Dec. 3. This object passed from south-east to north west over England and gave a vivid flash at its disappearance, quite dazzling in its intensity. About half a dozen other fireballs made their appearance between Dec. 2 and 5, and the curious fact in connexion with them was that they apparently had their derivation from different systems. About sixty observations have come to hand descriptive of these objects, and when further data come in it will be possible to compare them and make certain deductions as to the heights, velocities, and directions of the various meteors concerned.

"It is a pity that these fireballs are seldom correctly described. Few people possess a good knowledge of the constellations, and so it happens that casual observers are seldom able to describe a meteor's path in the sky with accuracy."

**Commensurabilities of Periods of Planets and Satellites.**—L. W. Topham contributes an article on this subject to the *Observatory* for November. He points out that there are very numerous cases in the solar system of close approximations to commensurability. The best known is the 2 to 5 ratio in the periods of Jupiter and Saturn; also the period of Neptune is nearly twice that of Uranus; among the satellites there is a relation between I, II, III of Jupiter; and in those of Saturn the periods of Tethys and Dione are nearly twice those of Mimas and Enceladus. He thinks it is reasonable to conclude that these relationships have some cosmogonic cause. He suggests that the satellites originally existed as clouds of corpuscles round their primaries; once a condensation was formed in these, other condensations might be set up, by resonance or some similar process, at distances where the period bore some simple relation to that of the first condensation. This would involve the conclusion that the relations originally held exactly, and that the cloud of corpuscles acted as a resisting medium, which was densest near the primary, so that the periods of satellites in this region were relatively more shortened than those of the more distant ones. This suggestion is shown to accord with many of the relations that he has noted in the article.

**Auroræ.**—*B.A.A. Journal*, Vol. 40, No. 1, contains a report from Mr. W. B. Housman on the observations of auroræ from July 1928 to June 1929. The greater number were observed by Mr. A. Johnson at Haroldswick, Unst, Shetlands. There is stated to have been increased auroral activity during the period, the displays during the magnetic storms of February and March being especially beautiful. For some years the auroræ have been tabulated in the report by the days of the solar rotations reckoned from the zero values of Lo according to Carrington's system. The region of maximum activity has been slowly shifting forward in solar longitude. In 1926–27 the numbers of auroræ in the four solar quadrants were 13, 28, 24, 11 respectively: in 1928–29 they were 18, 23, 26, 8. The region of maximum activity has shifted from the second quadrant to the third. This may mean that the solar regions chiefly concerned in these disturbances have a somewhat slower rotation than the value used by Carrington. In each period the sum of the numbers for the two middle quadrants is about double that of the first and fourth.

## Research Items.

**Religion of the Torres Straits Islanders.**—Dr. Haddon's Frazer Lecture for 1929, "The Religion of a Primitive People", delivered in the University of Liverpool, has now appeared in the *Annals of Archæology and Anthropology*. The Islands fall into three groups, in which culture was practically at the same stage, except in so far as affected by the fertility of the soil. For in the eastern islands the soil was rich enough to support the inhabitants on their garden produce, whereas in the other two groups they had to depend upon fishing. The Islanders are all Western Papuans, but belong to different stocks, two being long-headed, while the third has a broad head. When the white man arrived, the Western Islanders practised totemism, but among the Eastern Islanders it had disappeared. They believed in the continuity of life after death. Certain pantomimic ceremonies connected with this belief were said to have come from the island of Daru, off the coast of New Guinea. In the west the great funeral ceremonies were also the occasion for ceremonies connected with dugong hunting, when the spears, etc., were given fresh power. At these ceremonies the spirits of the dead were believed to be present. The ceremonies of Mer consisted of two main elements: (1) the dramatisation of a legend accounting for various matters connected with funeral ceremonies, and (2) the pantomimic representation of persons recently, and remotely, deceased as denizens of the spirit world. Certain men in Mabuiag were said to have friends in the spirit world and to have a gift of spirit divination. At Mawata a turtle ceremony was celebrated when the turtle were breeding. Various ceremonies in which masked dancers took part ensured good fishing and the ripening of wild fruits. Hero-cults invading the islands afforded an inspiring and consolidating influence previously lacking, but their origin is still obscure.

**Abnormal Teeth in Mammals.**—A weighty paper on abnormal teeth in certain mammals, and particularly in the rabbit, has been published by the veteran zoologist, Prof. W. C. McIntosh, who has just celebrated his ninety-third birthday (*Trans. Roy. Soc. Edinburgh*, vol. 56, 1929, pt. 2, p. 333). The chief contributions on the subject are summarised, and many new examples of abnormality are described and illustrated in 103 text-figures. The conclusion is reached that, amongst rabbits and other mammals as well, there is a close connexion between abnormalities of the teeth and congenital defect or disease. No case of abnormality in the teeth from injury was met with, and when injury was apparent, as in the distal arch of the mandible of a cat, the disrupted teeth were of normal structure.

**Physical Basis of Emanation Therapy.**—A recent paper by Prof. Stefan Meyer in the *Sitzungsberichte* of the Academy of Sciences of Vienna (vol. 138, p. 557) deals with the history of radium emanation in the body after it has been administered for therapeutic purposes. Whether it is introduced by way of the lungs or stomach, by far the greater proportion reappears in the air exhaled from the former organs. The content of emanation in the breath varies in a simple way with time, rising to a maximum and then falling off after administration in solution, and falling off continually but not exponentially when it has been introduced diluted with air. The two curves showing the amount of emanation in the breath at various times belong to types which are well known in the theory of the growth and decay of radio-active elements, but in this case the 'half-period' corresponds to transfer of emanation from one part of the body to another. The rate of transfer varies both with the individual and with his condition, but approximately ten minutes are required to evacuate half of the emanation in the lungs by way of the mouth, and about half an hour elapses before half of a charge of emanation in the stomach has been absorbed and passed to the lungs. When emanation is absorbed by the blood from the lungs and again returned to them, the corresponding half period is much the same as when it is passed from the stomach to the lungs. Other investigations are described in the same paper, which should prove to be a valuable contribution to the theory of radium therapy.

**Fisheries Industry in Japan.**—Among the most important industries of Japan is that of fishing, some figures regarding which were given by Mr. S. Kato in a paper to the World Engineering Conference held in Japan at the beginning of November (see *Engineering*, Nov. 15, p. 652). Japan is said to have an output of more than 2,000,000 tons of aquatic products, all but twice as big as that of Great Britain and Ireland. The fishing industry in Japan employs more than 1,000,000 people and 350,000 boats, as against the 90,000 men and 20,000 boats employed in Great Britain. The output per head and per boat in Japan is therefore comparatively small, but Mr. Kato gave particulars of the steam and motor fishing boats being developed in Japan by which the industry will be made more efficient. These boats are for bonito fishing, seine fishing, and for crab canning. Bonito fishing is carried on from April to September, and the boats for this are of 100 tons, with Diesel engines of 200 horse-power. The twin-screw seine fishing boats are somewhat smaller, but the floating canneries for crab fishing run from 700 to 4000 tons and are steam vessels. A 3000-ton steamer carries 2000 tons of coal, 20,000 cans, and 800 tons of fresh water. In addition to its crew, it has some 450 fishermen and other workmen. Such a parent ship is accompanied by motor junks and motor boats for the actual fishing. The equipment of a large crab cannery includes crushing, pressing, and drying machinery to make fish oil and fish meal from crab-waste.

**Fauna of Pitcher Plants.**—The general principle of the insect-trap in pitcher plants is well known, and the organisms ordinarily found living in the fluid of the pitchers are of an exceptional character. Since the fluid contains both proteolytic enzymes and bacteria, it would suggest the occurrence in these organisms of antiproteases to safeguard them from the action of the protease—a fact that has been shown to occur by Hepburn and Jones in the case of a fly larva (*Sarcophaga sarraceniæ*). In Part 7 of Vol. 6 of the *Journal of the Malayan Branch of the Royal Asiatic Society*, Mr. Cedric Dover discusses the pitcher-plant fauna of Singapore Island with particular reference to the resistance of mosquito larvæ to the action of the pitcher fluid. His experiments indicate that many of these larvæ living in such situations contain a potential pepsin resistance, which is developed in the presence of pepsin, and he suggests that a biochemist should study the question more fully. If his conclusions are substantiated, they would seem to indicate that environment is a powerful factor in altering the constitution of an organism. It is noteworthy that Culicid larvæ obtained from stagnant water were only able to survive in the pitcher fluid for a few hours, being almost completely dissolved in three or four days. Among the fauna of these plants,

Batrachian larvæ, fly larvæ, Protozoa, and other organisms are dealt with by different authorities in the groups concerned

**Australian Coleoptera of the Family Dryopidæ.**—In the *Australian Zoologist*, Vol 6, 1929, pp 50-71 (7 plates) Messrs. H J Carter and E H. Zeck contribute an important paper on the Australian representatives of this family of beetles These insects mostly frequent clear mountain streams, they are small or minute creatures varying from 1 mm to 5 mm. in length and very little is known concerning their biology. Although aquatic, they possess no special adaptive organs and are quite unable to swim They crawl about on the bottom of the water, and the authors record having kept living examples in a vessel of water for five months, without detecting any apparent attempt on the part of the insects to reach the surface Comparison with the New Zealand fauna reveals the interesting fact that all the Australian species, excepting two, belong to the subfamily Helminæ, which is unknown in New Zealand. The authors list forty one species, and of these twenty are described as new: two new genera are also diagnosed. The paper is illustrated by exceptionally good figures of these obscure insects, drawn by Mr. E. H Zeck.

**A Revision of the Copepod Genus *Sapphirina*.**—Anyone who has had the experience of examining a rich sample of plankton from tropical seas will probably recall his first meeting with a specimen of one of the large species of *Sapphirina* or *Copilia*. These extraordinary copepods may be very large—*S. iris* is 5-7 mm long—leaf like creatures so wholly transparent that their presence is perhaps only first realised when puzzling streaks or markings appear above some other object which is being examined While the beauty of these transparent copepods and the problem of their life history and probable semi-parasitic relation to *Salpa* make them of unusual general interest, their systematic study is extremely difficult. Lehnhofer (*Wiss. Ergeb. Deutsch. Tiefsee-Exp*, 22, Heft 5, 1929) has now given a revision of the whole genus *Sapphirina* which raises some points of special importance. He recognises 10 sharply defined species, but the remainder he finds impossible to treat in the same way. Six of them are bracketed in pairs as the extreme forms of unbroken variation-series, for example, *auronitens-sinuicauda*—while *nigromaculata* Cls. and *scarlata* Giesb. are dealt with as "angenaherten Arten" separable only by small differences in size and doubtfully distinct Lehnhofer gives in all cases curves of measurements which illustrate clearly the variability of the species This revision is purely systematic and does not appreciably advance our knowledge of the biology of the genus. Its chief interest lies in the presentation of a good example of the conception of species as groups with extremely wide range of variability, the limits of which are with difficulty definable.

**Antarctic Anemones.**—Dr Oscar Carlgren and Dr T. A Stephenson describe five new species of Actiniaria from the Australian Antarctic Expedition, 1911-1914 (*Scientific Reports*, vol. 9, Part 2, Series C, Zoology and Botany, April 1929), fourteen species in all being recorded. Embryos were found in the cœlenteric cavity in *Halianthella kerguelensis*, probably having entered the cœlenteron from the brood pouch. In *Bunodactis sulcata*, contrary to Clubb's statement that there are several brood pouches, there was found to be a single brood pouch containing large embryos with much yolk consisting of fat globules. Line drawings in the text illustrate various anatomical features, but there are no figures of the whole animals.

**Effect of Genes on Crossing-over**—A detailed analytical study of the influence of particular genes on the crossing over which takes place in the chromosome to which they belong has been made by Serebrovsky, Ivanova, and Ferry (*Jour. Genetics*, vol 21, No 2), using the genes *y* (yellow), a recessive lethal, and a dominant lethal (notch) at the left end of the X-chromosome It is found, in an investigation involving some 60,000 flies, that the introduction of mutations into a chromosome is accompanied by changes in the crossing-over values, especially near the locus of the introduced mutation The amount of such change is greatest for the notch lethal and least for *y*. This work is a continuation of work which began with the investigation of the effect of the gene 'purple' on crossing-over The presence of notch lethal increased the cross overs between eosin and echinus Similarly, the recessive lethal increased the crossing-over in loci near it, but with yellow the result was not so clear The results are explained in terms of the presence-absence hypothesis It is supposed that the appearance of a recessive gene actually shortens the chromosome, corresponding to a slight deficiency, and leads to asymmetry, reducing the amount of crossing-over. The introduction of genes into the chromosome mate will tend to lessen this asymmetry and so increase the amount of crossing-over.

**Studies on *Ranunculus*.**—Mixed sexual forms of flowers in *Ranunculus* have been recorded for many years and are now being intensively studied by Messrs. Marsden-Jones and Turrill. In a recent paper (*Jour Genetics*, vol 21, No 2) they record preliminary data regarding crosses between the various sex-forms, but thus far no consistent interpretation of the results appears Observations are also made on the yellow, lemon, and pale forms of *R. acris* and *R bulbosus* These colours are independent of the sex expression, and it is found that plants of all three colours can be heterozygous for colour In a field in Warwickshire the distribution of the pale flowered individuals indicates that they have spread from a single mutational ancestor. Mr. R O. Whyte, who is co-operating in a cytological study of the 'intersexes', has obtained some interesting results Male, female, and intermediate forms are found to differ in the length of the interval between the critical stages of pollen and embryo sac formation. This is associated with differences in the functional activity of the tapetum, which in turn may be determined by differences in the vascular supply to the different types of flowers In the form with 'female' flowers, the reduction divisions in anthers and ovules are coincident, whereas in normal hermaphrodite plants the anther meiosis is much earlier, and the tapetum fully functional. Another interesting fact brought out by these and other studies is that whereas the chromosome number for normal *R. acris* is 14 in England, Sweden, and New York, at Tzarskoe Selo 12 were found. The studies of Sorokin in America indicate instability in other characters associated with gynodimorphism and variations in the chromosome content of the nuclei

**Fossil Vertebrates of North America.**—The Carnegie Institution of Washington has produced Volume I of the "Second Bibliography and Catalogue of the Fossil Vertebrata of North America" (*Publication* No 390), by Dr O. P. Hay. There are 513 pages of bibliography, and an examination of this section makes the title of the work appear a little misleading, seeing that the entries cover a much wider range than American vertebrates alone There are, for example, more than seven columns devoted to Huxley's papers, or, to come to modern times, some ten columns

Abel's works, which again cover a wide field of palæontological investigation. Of this discrepancy between title and contents one can scarcely complain, seeing that the larger the bibliography is the more useful it is likely to prove. The second section consists of 400 pages devoted to a classification of extinct vertebrates from fishes as far as the amphibia, a supplement and index. A full cross reference to authors is given under each species mentioned in the catalogue. Errors in a compilation of this kind must be expected, but these are far outweighed by the obvious value of the work to students, whose time in searching out references will be much saved, and they owe a debt of gratitude to Dr. Hay for this great and laborious work. Its continuation, which is promised, will be welcomed.

**Survey by Air Photographs.**—The methods of surveying by the use of air photographs was the subject of a recent *Professional Paper* of the Air Survey Committee of the War Office. A continuation and amplification of that paper now appears in "Extensions of the 'Arundel' Method", by Captain M. Hotine (*Professional Paper*, No. 6, 4*s*. net.). The 'Arundel' method was designed for areas in which differences in ground height are less than one-tenth of the flying height. Among other aspects of the problem, this paper deals with the extension of the method of survey to mountainous areas. For this purpose an experimental survey was made of Glen Clova in Forfarshire (Angus), and the result is published on a scale of 1 to 20,000 with a contour interval of 50 feet. It was found necessary to set the time interval of exposure for overlap by observation on the high ground, for the normal overlaps, forward and lateral, are otherwise shortened or excised for considerable elevations. The lighting of steep slopes involves consideration in time of flying, the eastern and western slopes being best photographed in the morning and evening respectively. Valley mists and vertical air currents were minor difficulties and the pilot had difficulty in maintaining a constant height over this type of country. The paper goes on to consider contouring and plotting.

**Superconductivity in a Compound.**—A fresh case of superconductivity is described by Prof. W. Meissner in a communication from the Physikalisch-Technische Reichsanstalt appearing in the issue of the *Zeitschrift fur Physik* for Nov. 9. When copper wire is heated in the vapour of sulphur, it passes into copper sulphide (CuS) without change in geometrical form. The resulting material has a specific resistance of $4 \times 10^{-5}$ at 0° C., and—taking this value as a convenient unit—a resistance of 0.30 at the temperature of liquid air (86° absolute), and one of 0·02 in boiling hydrogen (20° abs.). At the normal boiling point of helium (4° abs.) the resistance has fallen further, to 0·004, but below this temperature it remains almost constant down to 1·66° absolute, when a sudden drop takes place to an immeasurably small quantity, which then persists for temperatures below about 1·55°. The occurrence of superconductivity in a compound is in itself important, and it is also remarkable that the residual constant resistance found immediately before the superconducting state is attained has the small value which has hitherto always been found to be associated with very pure metals.

**Structure of Complex Compounds.**—The structures of complex polyacids is now generally explained by a theory due to Miolati and Rosenheim, based on Werner's theory. Whilst this enables a considerable amount of order to be brought into the chemistry of these compounds, it is not always satisfactory and is sometimes rather arbitrary. In the April and October numbers of the *Journal of the American Chemical Society*, L. Pauling has put forward an alternative method which seems to offer possibilities in those cases where the structure may be regarded as formed of anions and cations. The method is somewhat on the lines of that used by W. L. Bragg in elucidating the structure of silicates and depends on the use of crystal data. In considering the tungstosilicate ion, for example, it is pointed out that the crystal radius of the ion $W^{+6}$ is such that six oxygen ions could be grouped about it at corners of an octahedron. Stable complexes can then be formed by arranging $WO_6$ octahedra in such a way that they share corners with each other. A number of subsidiary principles enter, for which the originals must be consulted.

**Optical Activity of Diphenyl Derivatives.**—Prof. Kenner's discovery of optical activity among derivatives of diphenic acid has led to the adoption of the interesting suggestion of W. H. Mills that the presence of substituents near to the junction of the two aromatic nuclei produces mechanical interference of free rotation of the nuclei about their common link. This view has been supported by the work of Meisenheimer and, in the November issue of the *Berichte der deutschen chemischen Gesellschaft*, further experimental evidence in support of it is brought forward by F. Pufahl, who describes some hitherto unknown derivatives, which contain substituents in the 5·5′ positions. These resemble the 4 4′ derivatives in being optically inactive and in giving rise to anhydrides. Thus the resolution of derivatives into optical isomerides appears to be confined to such as contain substituents in the 6·0 positions.

**Rates of Saponification of Oils.**—Very little work has been done on the rates of saponification of oils and of pure triglycerides by aqueous alkali, and the experiments described by McBain, Humphreys, and Kawakami in the October number of the *Journal of the Chemical Society*, which add considerably to the information on this subject, are therefore of interest. A large number of materials, including commercial oils and fats, were used, and the rates of saponification by soda were measured under strictly comparable conditions. All reagents were kept in large excess except the dilute hydroxide, the rate of disappearance of which was followed by means of the hydrogen electrode and was found to be unimolecular so far as the hydroxyl ion is concerned. A soap was used as a constant emulsifying agent and the liquid was rapidly stirred. Castor oil was most rapidly saponified, and colza oil most slowly. Lard is rather rapidly saponified, but olive oil slowly, this oil being next to colza oil. Two specimens of lard showed rather different rates. The range of time is great, being 200-fold for the extreme cases. This is due, according to the authors, to the different ease and degree of emulsification of the various oils. In saponification, as in other related fields, reactions are supposed to take place at the interface between oil and water and not in either phase, and hence the primary factor is the development of this interface, which is favoured by emulsifying agents and by the degree of readiness of the oil to be emulsified. Free fatty acid in the oil increases the readiness to emulsify. Apart from castor oil, there is a relation between iodine value and rate of saponification, unsaturated oils being slower than saturated. Multiple double bonds in the carbon chain seem to inhibit saponification more than single ones such as oleate radicals. There is no relation between the emulsifying power of a soap and the emulsifiability of the corresponding oil.

## Water Power Development in Canada and Malaya.

A NOTABLE step in the development of Canadian water power resources has just been taken in the inauguration by His Excellency the Governor-General of constructional operations for the power house which is to be erected by the Beauharnois Power Corporation just above the shores of Lake St. Louis, near the village of Beauharnois

The scheme includes a canal for the diversion of the water of the St Lawrence River for power production and also for navigation purposes This canal, work on which has been commenced by the formation, simultaneously, of two dykes at Valleyfield, when completed, will have a depth of 30 ft., which will be sufficient to accommodate the largest vessels now navigating the Great Lakes The power station will utilise the 83 ft. fall in the St Lawrence River between Lakes St. Francis and St Louis, which lie just above the city of Montreal It is claimed that it will ultimately become the largest hydro-electric generating station in the world.

The present programme is to provide a development of 200,000 horse-power by Oct. 1, 1932, but it will be possible to increase this figure, which is the minimum limit, to 350,000 h p by the same date, if so required, and a primary objective of 500,000 h p. has been decided upon by the executive officials of the organisation. The extent of ultimate development will depend on the quantity of water permitted to be diverted from the St. Lawrence. The company has, at present, been conceded the right to divert 40,000 cusec (cu. ft. per sec.) Across the river on the left bank, the Cedar Rapids installation of the Montreal Light, Heat, and Power Consolidated is generating 200,000 h p. from a head of only 32 ft. If this water were diverted through the Beauharnois Canal, it is claimed that there would be a threefold economy and that nearly 600,000 h p could be developed. It is stated, furthermore, that an ultimate development of two million h.p would be possible if the whole of the water in the St. Lawrence channels were diverted through the canal.

In the meantime, the project in hand involves the expenditure of 16,000,000 dollars on the canal and a total expenditure estimated at 65,000,000 dollars for the installation of 500,000 h p During the next three years the countryside on the south bank of the St Lawrence from Beauharnois to Valleyfield will be the scene of constructional operations of considerable magnitude among enterprises in the history of Canadian water power development

In the *Metropolitan Vickers Gazette* for October there is an interesting account of the Perak River hydro electric scheme which is being erected in the Federated Malay States and will be opened next year. It illustrates some of the difficulties that have to be overcome in setting up one of the latest products of engineering skill in the Far East The photographs shown of 66-kilovolt overhead wires and substations are very similar to corresponding systems in Europe

The main supply station is a hydro-electric one situated on the west bank of the Perak River, sixty miles north of Malim Nawar It is the main supply station but it works in parallel with a steam station All the outdoor substation structures are flood-lighted at night Double parabolic reflector type projector lamps are fitted on the top of steel poles fifteen feet high. The only objection to the lighting is the fatal attraction it has for the many insects with which the country abounds. The crowds of flying beetles round these lamps sometimes alarm the superstitious watchmen. The working of the whole system is almost entirely automatic The Cambridge Instrument Co. has supplied the temperature indicators and alarm equipment for the whole scheme Thermocouples are provided, the temperature of the cold junction being kept constant by a thermostat. Chinese, Indian, and Malay native workmen were employed. The atmosphere compelled attention to all flesh wounds, but the iodine treatment caused the natives to flinch, although they would cheerfully cauterise a wound with a lighted match.

## Conversion Tables for Galactic Co-ordinates.

PROF. PIO EMANUELLI, secretary of the Vatican Observatory, has just published an extensive table for the conversion of Right Ascension and Declination into galactic co-ordinates, which forms an appendix to vol. 14 of the *Publications* of the Observatory

The author gives a summary of the various positions of the north galactic pole as determined by different authorities, and decided to adopt Newcomb's value (slightly modified), rather than a combination of different values. The adopted position of the pole for the equinox of 1900 is R A. 191·1°, North Decl. 26·8°. It is within half a degree of Heis's position.

In reducing to galactic co-ordinates, a zero of galactic longitude must be selected Most authorities up to the present have adopted the intersection of the galactic equator with the equator of 1900 This is open to objection since the equator changes greatly owing to precession, and the equator of 1900 would be very inconvenient in distant epochs in the future. Dr. Innes suggested using the galactic longitude of the solar apex, which is assumed to be R.A. 270°, North Decl. 30°, for the equinox of 1900. This is the value adopted in the tables, although the author points out that the International Astronomical Union decided both in 1925 and in 1928 that the star Alpha Cygni should be taken as the zero of longitude. It has the double advantage of being close to the galactic equator (distance one degree) and of having almost insensible proper motion Further, it is a definite and brilliant point, whereas the solar apex is invisible, and is uncertain by a few degrees; moreover, it is 22° from the galactic equator However, the table can easily be adapted to give longitudes from Alpha Cygni, it is only necessary to *subtract* (not *add*, as erroneously stated both on p. xv and p. xix) the quantity 27·9°; another erratum in the tables is that this correction is stated to vary with the epoch; it is constant and independent of precession. The correction to reduce the longitude to the intersection of the galaxy with the equator of 1900 is +23·6°; with the equator of 2050 it is +23 8°.

The tables give $l$, $b$, the galactic longitude and latitude, to the nearest tenth of a degree for every ten minutes of time in R.A. and every degree of declination. There is a supplementary table for every minute of R.A in the neighbourhood of the galactic poles. Attention should be paid to the short list of errata at the end of the tables.

Rev. J. G. Hagen, S J., the Director of the Observatory, contributes a preface, in which he notes that the tables will be applied to obtain the galactic co-ordinates of the nebulæ observed by him; they will be mapped on an equal-area projection.

## Rice Grass and Land Reclamation.

THE economic possibilities of *Spartina Townsendii*, commonly known as rice grass, are described in an illustrated booklet issued by the Ministry of Agriculture (Miscellaneous Publications, No 66, price 8d) The grass, a tall rhizomous, deep rooting plant, occurs on maritime muds and was first recorded in England on the Southampton salt marshes in 1870 Its spread along the south coast has been very rapid, from fifteen to twenty years being usually sufficient for the conversion of waste land into continuous meadow Propagation is effected by seed or fragments of runners

The value of *Spartina* lies in the fact that it is particularly suitable for land reclamation and protection, and at the same time can be used for feeding to stock The grass, owing to its extensive underground system, has the property of binding the mud in which it grows, and with the help of silting brings about a rise in the level of the land. Valueless mud flats can thus be brought into use, and sea walls or banks protected from erosion by consolidation of the mud in front. As food for stock, *Spartina* offers great possibilities. All farm animals eat it readily, whether cut fresh or as hay, and since it remains on its root throughout the winter, it forms a convenient reserve food

The composition of *Spartina*, apart from mineral matter, is somewhat similar to good meadow hay, and preliminary feeding trials showed it to be fully digestible to sheep

Experiments are in progress at the East Anglian Institute of Agriculture to determine the best way of introducing and growing *Spartina*, particularly with the view of feeding it to stock The question as to whether it can be used most profitably fresh, or as hay or silage, are among other problems under investigation.

Although sufficient time has not yet elapsed for any definite results to have been obtained from the experimental plantings in Essex, the growth appears entirely satisfactory, and there is every prospect of its proving valuable to the farmer. In other countries of temperate climate *Spartina* also grows readily. The natural spread of the plant along the coast of France has been most impressive, and cuttings exported from Poole Harbour for experimental planting on the muds of Holland have rapidly become established. The plant seems likely to prove of inestimable value in the solution of the ever-present problem of land reclamation and protection in the latter country.

A feature that must not be overlooked when plans for the introduction of *Spartina* to an estuary are contemplated, is the inevitable reduction in the flow of tidal water when the plant becomes established In certain circumstances this might adversely affect navigation or land drainage. Apart from this, however, the economic possibilities of *Spartina* appear very promising.

## University and Educational Intelligence.

CAMBRIDGE.—C. F. A. Pantin, of Trinity and Christ's Colleges, has been appointed University lecturer in zoology for three years. J. E. E. Craster, of Downing College, has been appointed University lecturer in geography for three years.

Dr. F. P. Bowden has been elected into a fellowship at Gonville and Caius College.

RESEARCH scholarships for the encouragement of work in sanitary science are being offered by the Grocers Company. The scholarships are of the value of £300 a year, plus an allowance for apparatus and other expenses, and are tenable for one year, with possibility of renewal for two or three years Applications must be received by the Clerk to the Grocers Company, Grocers Hall, E C 2, before the end of April next

BIRKBECK College, which has since 1920 enjoyed the status of a school of the University of London, has sent us with its Calendar for 1929–30 the first annual Haldane memorial lecture, delivered last May by Lord Justice Sankey The governors of the College resolved, on the death of Lord Haldane, who had been its president from 1919, to institute this annual memorial lecture in his honour, and the first of the series is devoted, appropriately, to an estimate of his work as lawyer, statesman, and philosopher, and the meaning, object, and value of the adult education movement which he did so much to foster.

THE annual conference of the Geographical Association will be held on Jan. 2–6 at the London School of Economics, Houghton Street, London, W C 2, under the presidency of Sir Henry Lyons, who will deliver his address on the first day of the meeting. The programme includes discussions on the physical basis of geography in independent schools, to be opened by Mr. B. B. Dickinson, geography and the training of teachers, to be opened by Mr. T Herdman, and lectures by Mr. H. E. Raynes on the mortality of Europeans in equatorial Africa, by Colonel H L. Crosthwait on air survey, by Sir John Russell on agricultural developments in South Africa, and on national parks by Dr Vaughan Cornish. The week-end will be devoted to an excursion to Norwich. The president-elect of the Association is Mr B. B. Dickinson On Jan. 2–4, a publishers' exhibition of books, maps, and geographical appliances will be open for the use of those attending the conference.

UNIVERSITY College, London, announces in its Calendar for the current session numerous post-graduate courses of lectures (open to students of other London colleges under the inter-collegiate scheme) and facilities for research in its faculties of arts, laws, science, medical sciences, and engineering, and in the Bartlett School of Architecture. Among recently developed departments of work in the College is that connected with the Ramsay Laboratory of Chemical Engineering Here the bulk of the work will be of a research character and directed towards the elucidation of industrial problems The Calendar contains a list, running to 28 pages, of original papers published during the past year in the various departments, the most prolific of which is the department of physiology and bio-chemistry, which was responsible for fifty-three original papers. Among voluminous appendices appears Sir Gregory Foster's annual report for 1928–29, a year noteworthy in the history alike of the College and the University as that in which statutes giving effect to the new constitution of the University were sealed and the new University Court and Collegiate Council were established, and the Calendar contains, very appropriately, an eloquent tribute to Lord Haldane's services to University education in general and the University of London in particular. "No man of his own or any other generation", said Sir Walter Morley Fletcher in recounting those services in the course of his address to the assembly of the faculties of July 4, "has done more to promote the growth of University education in this country." University College, having enjoyed for twenty-five years the leadership of Sir Gregory Foster, will shortly welcome his successor, Mr. Allen Mawer, who is to take over its administration as Provost on Jan. 1, 1930.

## Calendar of Patent Records.

**December 14, 1688**—On Dec. 14, 1688, Abraham Thevart was granted a privilege for 30 years by Louis XIV "de faire seul, à l'exclusion de tous autres, de fabriquer où bon leur semblera, des glaces de soixante pouces de haut, sur quarante pouces de large, et de toutes autres hauteurs et largeurs au dessus, . . . et pour cet effet se servir seulement des machines que ledit Thevart a inventées", on condition that a description of the process be presented within three months. Thevart set up his factory first in the Faubourg St. Antoine and later at St. Gobain, where large sheets of glass were cast in 1693, the first four pieces being presented to the king In England the first large glass sheets were manufactured by the Company of British Cast Plate Manufacturers, formed in 1773, in a factory at St. Helens, Lancashire

**December 15, 1883**—It was Gottlieb Daimler who first realised the importance of high piston speeds for the internal combustion engine, and the motor-car industry really dates from his patent, which was applied for in Germany on Dec. 15, 1883 His first engine—a four-stroke engine running on benzene—was built into a bicycle, which was driven for the first time in November 1886 in the streets of Cannstatt.

**December 16, 1835.**—Henry Booth, one of the chief promoters of the Liverpool and Manchester Railway, and the first secretary of the Company, invented the common screw coupling for railways. It was adopted by his company and has continued in use to the present day. His patent, dated Dec 16, 1835, for "an improved method of attaching railway carriages together for the purpose of obtaining steadiness and smoothness of motion", probably was for this invention, but no specification was enrolled and the patent became void within two months of the grant

**December 20, 1822.**—The first 'eversharp' pencil was patented in England by John Isaac Hawkins and Sampson Mordan on Dec 20, 1822, with the title "Improvements on pencil holders for the purpose of facilitating writing and drawing by rendering the frequent cutting of the points unnecessary." The projection of the lead was governed by screw mechanism within the pencil holder

**December 21, 1612.**—The patent granted to Joseph Usher, Warner Rich, and Godfrey Devette, on Dec. 21, 1612, for a new engine for supplying water to cities and towns and private houses, etc, contains a provision that a model of the invention is to be supplied within one month from the date of the grant, and furnishes an early example of the official requirement of a description of the invention as a condition of the grant. Sir Hugh Myddleton's patent for the supply of water to London was granted in the previous May, and this may have been the cause of the insertion of the proviso in the later grant.

**December 21, 1736**—Jonathan Hull's patent for his "machine for carrying vessels or ships out of or into any harbour, port, or river, against wind or tide or in a calm", was granted on Dec 21, 1736 Hull proposed to use a Newcomen engine to propel a tug-boat, by means of a stern paddle wheel operated through rope gear and pawl and ratchet mechanism. His experiments were presumably not successful, but he published in the following year a book describing the invention, which may have stimulated the later inventors.

**December 21, 1802**—"Tatham's Clumps", which were interlocking bricks for building circular structures such as wells, columns, pipes, etc, were patented by William Tatham and others on Dec. 21, 1802. The bricks were made at the works of Scott and Clarkson, at Hackney.

## Societies and Academies.

### LONDON

**Royal Society**, Dec 5—**F A. B Ward, C E Wynn-Williams, and H M. Cave** The rate of emission of alpha particles from radium A new type of electrical counter was used in which the whole of the amplification is produced by triode valves The amplification was linear, so that the counting of α-rays was undisturbed by the presence of β rays About 500 particles per minute could be counted. The rate of emission from radium determined by counting about $10^5$ α-particles was $3 \cdot 66 \times 10^{10}$ α particles per sec per gm. of radium.—**E J Williams and F. R. Terroux**. Investigation of the passage of fast beta particles through gases The primary ionisation for beta particles of 0·5-0 9 of the velocity of light, determined in the Wilson cloud chamber, appears to approach limits of 22 ions per cm in oxygen, and 5 ions per cm in hydrogen. Variation with velocity differs appreciably from that predicted on classical theory From the frequency of branch-tracks, the magnetic moment of an electron seems considerably less than a Bohr magneton. Momentum appears to be conserved in branch collisions—**R. J. C Howland**. On the stresses in the neighbourhood of a circular hole in a strip under tension The problem is solved by successive approximation for the case in which the stress-system is symmetrical both about axis of strip and about perpendicular diameter of hole General formulæ are given expressing each approximation in terms of the preceding The coefficients of the transformation depend upon transcendental integrals which are estimated numerically and coefficients are then tabulated When the ratio of diameter of hole to diameter of strip does not exceed 0·5, greatest stress at boundary of hole is nearly $4\frac{1}{3}$ times tension at infinity. On the edge, tension rises from a minimum of less than $\frac{3}{4}$ of applied tension at point nearest to hole, to maxima, not much less than twice applied tension, at about one-third of width of strip on either side of central section. On the axis, disturbance due to hole becomes inappreciable at a distance from centre of hole equal to about $1\frac{1}{2}$ times width of strip.

**Geological Society**, Nov 20—**D. Williams**: The geology of the country between Nant Peris and Nant Ffrancon (Snowdonia) The general stratigraphical succession is given The topmost Cambrian beds, the Ffestiniog or *Lingula* Grits, are of shallow-water origin. They are faulted against blue-black slates, probably of Lower Llanvirn age. Upwards, the slates pass into the paler Llandeilo slates with *Glyptograptus teretiusculus*, at the top of which occur the Talgau lavas apparently belonging to the Glyder Fach-Capel Curig volcanic suite. These earliest flows are notably sodic. The Snowdon Volcanic Suite is essentially composed of potash-rhyolites and rhyolite tuffs, succeeded, near the Devil's Kitchen, by pumice-tuffs and flows of andesitic or basaltic character. The Upper Rhyolitic Series of Snowdon itself is here absent. Two large acid plutonic masses, Moel Perfedd and Bwlch-y-Cywion, are believed to represent the denuded plugs of the vents from which the Lower Rhyolitic Series was extruded. Both the folding and the cleavage, which strike approximately north-east and south-west, are attributed to Caledonian earth-movements, the cleavage following closely upon the folding, but preceding the faulting. 'Cleavage-fans' are conspicuous, two 'synclines' being separated by an 'anticline'. There appears to be no evidence in this area of the post-cleavage thrusting observable on Snowdon.—**Beeby Thompson**: The Upper Estuarine series of Northamptonshire and

northern Oxfordshire J W Judd, in 1867, gave the name 'Upper Estuarine Series' to a series of variable beds, largely variegated clays containing abundance of vegetable matter of probably freshwater origin, interspersed with brackish water beds and with distinctly marine beds The author in 1909 recognised an 'Upper Estuarine Limestone', commonly a water-bearing bed in the midst of the series This bed divides the series into three parts, on which additional information is given In northern Oxfordshire, between certain inferior oolite limestones or white sands (the time-equivalents of the Lincolnshire limestone ?), or ferruginous sands (the equivalents of the variable beds of the Northampton sand or even of the ironstone series) below, and the great oolite limestone above, occurs a series of beds which in various parts physically, and in others palæontologically, agree, as does the complete set in sequential position, with the Upper Estuarine Series of Northamptonshire The Northamptonshire and Oxfordshire sections on this geological horizon are thus more definitely correlated In Part 2 of the paper it is shown how the extended classification of beds can be used for identifying unconformities due to earth-movements developed at different times.

Linnean Society, Nov 21.—M J. Godfery. The pollination of *Cephalanthera.* The three British species can be cross-pollinated by insects, though there are no viscid glands to attach the pollinia An insect retreating from the flower becomes smeared with the viscid secretion of the stigma, which then picks up the pollinia projecting from the anther —E. B. Poulton · Recent observations on snake-like caterpillars which throw light on a statement in H. W. Bates's classical paper on mimicry. Bates was probably referring to a Sphingid larva which deceived him by the reduction of the caudal horn to a mere hump in the final stage The two larvæ, *Leucorhampha triptolemus* Cram and *L ornatus* Rothsch, behave exactly as Bates described, and bear their terrifying eye like marks on the ventral surface —S. K. Montgomery · Report on the Crustacea Brachyura of the Percy Sladen Trust Expedition to the Abrolhos Islands under the leadership of Prof W. J. Dakin, D Sc., F L S, in 1913; along with other crabs from Western Australia Of 57 species and varieties in the collection, there are 8 species and 4 varieties described as new; and a new genus is suggested to contain one of these, along with *Grapsus inornatus* (Hess) and *Brachynotus octodentatus* (Milne-Edwards) The Brachyuran fauna of the Abrolhos Islands is more nearly related to that of the north of Australia than to that of the south and south west The Ninety Mile Beach, north of Broome, has divided the Brachyura into a northern and a north-western group. The relative absence of the Oxystomes both from the north western and the southern groups is noted. The Brachyuran fauna of Australia as a whole, and of the south of Australia in particular, varies considerably from the general homogeneity of the Indo-Pacific.

Physical Society, Nov 22.—D. P. Dalzell. Heaviside's operational method. The method of treatment incorporates the views of the late T. J. I'A. Bromwich with those of J R. Carson, and is identical with that advocated by Van der Pol It involves unrestricted use of complex integration as employed by Bromwich, and thus avoids such uncertainties as arise from the use of operators denoted by incomplete symbols. The theory of integration provides a complete explanation of all the aspects of Heaviside's method of solving differential equations —E. T. Hanson: The dynamical theory of resonators. The theory of the small resonator with neck communicating with the open air depends upon the assumption that the air within the neck may be treated as an incompressible fluid The theory is extended to include generally necks of variable cross section —E C Atkinson. Escapement errors of pendulum clock Prof. Sampson's theory of maintenance is applied to find equations for the errors of rate caused by changes in intensity and limits of the impulse and in friction of moving parts of the impulse mechanism For the Cottingham clock, rigidity of the stops limiting the impulse is the most important point in design The equations are also given for the dead beat escapement and show that working conditions which are good so far as friction is concerned are bad for barometric changes The method used for computing 'remote' error in these cases must be modified when the inertia of the impulse mechanism is appreciable as in the Shortt clock.

DUBLIN

Royal Irish Academy, Nov 11.—J J Nolan and J. G. O'Keeffe: The ions produced by discharge at liquid surfaces Chattock's method is used to determine the mobilities of ions produced in discharges at water and alcohol surfaces. The ions are of the same character as those produced by discharge at metal points or by the ionising radiations. The observation of Tyndall and Phillips, that in air saturated with *n*-butyl and *n*-amyl alcohols the mobility of the positive ion is greater than that of the negative, is confirmed.—Miss A. L Massy · The Mollusca of the Irish Atlantic Slope. The Mollusca (other than the Cephalopoda, Amphineura, Pteropoda, and Heteropoda and Nudibranchia) taken by the Fisheries Branch of the Department of Agriculture, Dublin, on the west of Ireland since the year 1900: the area covered is between lat 49° N. and lat 56° N. Records east of the Fastnet Light, Co. Cork, have been excluded and the western boundary is the 1500 fathom line. Many rare deep-water species have been captured. 313 species are enumerated, and under the fossil distribution will be found many records from Irish and Scandinavian sources not very accessible to students of the group.

PARIS.

Academy of Sciences, Nov 4.—Eugène Slutzky: The extension of the theory of periodograms to series of dependent quantities.—B. Demtchenko. An inverse problem to the problem of Dirichlet.—Henri Cartan: The zeros of the linear combinations of $p$ given integral functions —Georges Valiron: Meromorph algebroid functions —A. Markoff, jun.: Nearly periodic movements —E. G Barrillon: Concerning discs rotating in a fluid —R. de Mallemann. The calculation of the atomic frequencies in solids. The formula of Lindemann rests on the hypothesis that at the melting-point the amplitude of the atomic vibrations should be equal to the mean distance of the atoms. From the author's calculations this is inexact, and the ratio is smaller than unity, 0 06 for aluminium, silver, gold, platinum, copper, iron, nickel, cobalt; 0·08 for the alkaline metals; and 0·04 for liquid mercury. This ratio is practically equal to the product of the coefficient of expansion and the absolute temperature of fusion.—Albert Turpain and Michel Durepaire: The electric charges developed in certain amorphous dielectrics under the action of pressure. This phenomenon is exhibited by ebonite, paraffin, glass, and especially by crêpe rubber. A diagram is given showing the electrical charges produced in rubber as a function of the pressure.—E. Pierret: A new mode of receiving ultra short [electric] waves, 10 cm–18 cm. wave-length —L.

Jolland The conductivity of solid salts at high temperatures—G. Bruhat and R Legris: The absorption of aqueous solutions of tartaric acid and of alkaline tartrates—P. Vaillant. The absorption spectrum of cobalt chloride and its variations. Six solutions of cobalt chloride were studied, the first pair in water varying in concentration, the other four at the same concentration but in varying solvents Analysis of the results showed that the ion $Co^{++}$ acted throughout as the only absorbing agent, its activity varying with the concentration and with that of the other ions in the solution—R. Gindre A phenomenon of atmospheric optics—Jean Thibaud and Jean J Trillat: The diffraction of the X-rays in various substances, principally in liquids—A. Grumbach and S Schlivitch. The rôle of the atmospheric oxygen in photoelectric batteries with coloured liquids—A. Boutaric and Mlle. M. Dupin The slow evolution of mixtures of colloidal solutions resembling anaphylactic effects.—M. Bourguel and Mlle. V Gredy: The selective action of a hydrogen catalyst A study of the addition of hydrogen to phenyl acetylene with colloidal palladium as the catalyst. The determination of the velocities of hydrogenation shows that the reaction takes place in two distinct stages, first the production of phenylethylene and then the formation of the saturated hydrocarbon. The reaction velocities of these two stages differ considerably, and if, after the complete conversion into phenylethylene, the reaction velocity for the second stage is reached, the fresh addition of phenylacetylene to the mixture re-establishes the velocity of the first stage—Albert Portevin and Pierre Chévenard. The influence of the fineness of structure at the time of annealing grey cast irons—Dumanois and Mondain-Monval: The direct oxidation of hydrocarbons by the air. A closed bomb containing pentane and air under pressure was maintained at various temperatures between 80° C. and 230° C., portions being withdrawn from time to time and tested for carbon dioxide and for aldehydes. It was shown that some degrees below the temperature of spontaneous inflammation, chemical reactions were taking place in the mixture, heat being disengaged and carbon dioxide and aldehydes being formed Similar results were obtained when the pentane was replaced by other hydrocarbons (hexane, heptane, octane).—G Dupont and J. Lévy: The auto oxidation of abietic acid.—Georges Darzens: The condensation of the chloride of dimethylacrylic acid with benzene: dimethylvinylphenyl ketone as a product of the reaction. This reaction does not give the hydrindone which might be expected, the reaction stopping at the first stage, dimethylvinylphenyl ketone, $C_6H_5 . CO\ CH = C(CH_3)_2$—Maurice Nicloux. The micro estimation of carbon and the estimation of this element in arable soil A modification of the method described in earlier communications avoiding the use of a microbalance.—C. P. Nicolesco The discovery of the Cenomanian in the valley of Ganzeville (Seine Inferieure).—Pierre Lesage. Continuation of researches on precocity and its heredity in *Lepidium sativum*.—M. Bridel and J. Rabaté: Variations in the composition of new branches of *Amelanchier vulgaris*. Determinations of the ameliaroside in the fresh branches showed large variations from month to month: no reasons for this variation can be assigned at present.—Et. Föex and Et. Rosella: Contributions to our knowledge of the *Piétin* of wheat—J. Magrou, Mme. M. Magrou, and P. Reiss: Action at a distance of various factors on the development of the egg of the sea-urchin.—Mlle. Choucroun. The hypothesis of mitogenetic radiation.—A. Blanchetière: The pepsin and trypsin hydrolyses of the gliadin of wheat in their relation with the formation of the diacipiperazines.

BRUSSELS.

Royal Academy of Belgium, April 13—Th. De Donder The invariantive theory of the calculus of variations (4)—Oct Dony (1) An experimental contribution to the study of heating and of electric furnaces. The author replaces platinum, or refractory alloys such as nichrome, with soft iron of large cross section, up to 5 mm diameter for cylindrical wires. The currents employed were of the order of 200 amperes, and with suitable heat insulation, temperatures of 1150° 1200° C could be maintained for long periods Examples of laboratory applications of these furnaces are given—(2) The reduction of zinc oxide by gaseous carbon monoxide at atmospheric pressure and at high pressures The electric furnace described above has been applied to the reduction of zinc oxide in carbon monoxide at 1100°-1300° C—D. Pompeiu An integral property of functions of two real variables.—Jean P Bosquet Some fundamental formulæ of the invariantive theory of the calculus of variations—Louis van den Berghe Observations on the sense of smell and on the mechanism of the olfactory currents in some Teleostians. The detailed study of five species, with ten illustrations, is given The sense of smell varies greatly in different forms; *Blennius pholis* finds its prey both by sight and by smell, whereas *Cottus bubalis* does not use the sense of smell—Maury Report of the geodesic section of the Institut Cartographique Militaire—Lucien Godeaux: The fundamental curves of birational transformations of space.—André Grosjean: The discovery of a horizon with marine fauna at the Limbourg-Meuse coal mine at Eysden (Belgian Campine).

May 7.—G Cesàro The directions of extinction of an ensemble of two parallel crystalline plates, placed, in monochromatic light, between a fixed polariser and a movable analyser. The conditions necessary for the existence of extinction positions. The fictitious spherical triangle from which these relations can de deduced—Cl Servais: The geometry of the tetrahedron—L Godeaux: Point correspondences between surfaces.—J Pasteels: Analysis of the physiology of the egg of the pholas (*Barnea candida*).—A. De Waele The influence of carbon dioxide on the vernal awakening of the snail There is an optimum temperature (about 18° C.) for ending the snail's winter sleep: for the same temperatures moisture favours the awakening, and moist carbon dioxide has the same effect. Dry carbon dioxide prolongs the hibernation—F. Dacos: A crucial experiment for the diffusion of electrons.—E Leloup: The maturation and fecundation of the egg of *Salpa fusiformis*—M. Cosyns and R Moens: Note on piezo-electric quartz. Researches on the limits of the accuracy obtainable with a quartz crystal utilised as a frequency standard. The different factors capable of modifying the frequency are studied singly. The method utilised has the advantage of being a zero method, and at present has an accuracy of the order of one in 10,000—G. van Lerberghe: The characteristic equation of perfect solutions and of regular solutions.

June 1.—Th. De Donder: The invariantive theory of the calculus of variations (5).—Cl. Servais: The geometry of the tetrahedron (2)—Lucien Godeaux: The connected points of cyclic involutions of order three belonging to an algebraic surface.—Marcel Winants: A generalisation of Fredholm's equation.—P. Swings and Fl. Bureau: The integration of the equation of the quasi-Keplerian orbits by the method of successive approximations.—G. van Lerberghe and Mlle. G. Schouls: A characteristic equation of binary gaseous mixtures.

## Official Publications Received.

BRITISH

The Victorian Bush Nursing Association Report and Statement of Accounts to 30th June 1929 Pp 244 (Melbourne)

City of Belfast New Museum and Art Gallery Publication 97 Guide to Casts of Greek and Roman Sculpture By I A Richmond Pp 28 (Belfast) 3d

Transactions and Proceedings of the Botanical Society of Edinburgh Vol 30, Part 2, Session 1928-29. Pp ix-xx + 67 186 + plates 8 13 (Edinburgh) 7s 6d

Air Ministry Aeronautical Research Committee Reports and Memoranda No 1245 (E 31) Fuel Flowmeters designed to measure Mass Flow By P S Kerr, with Appendices by D Robinson, R J Penn and W C. Cooper (I C E 660 I C E 676 I C E 693) Pp 21+8 plates (London H.M Stationery Office) 1s net

The Royal Technical College, Glasgow Annual Report on the One Hundred and Thirty third Session adopted at the Annual Meeting of Governors held on the 15th October 1929 Pp 78 (Glasgow)

John Innes Horticultural Institution Conference on Polyploidy held at the Institution on January 19th, 1929, to commemorate the Centenary of the birth of the Founder, John Innes Pp 48 (London)

Education and the League of Nations being the Report of the Joint Committee of Enquiry into the Teaching of the Aims and Achievements of the League of Nations Pp 28 (London)

Report of the Second Quarterly Meeting of the Ross Institute Industrial Anti Malarial Advisory Committee, held in the Council Chamber of the Rubber Growers' Association, 2 Idol Lane, E C 3, on Monday, October 14th, at 2 30 P M Pp 8 (London Ross Institute and Hospital for Tropical Diseases)

Imperial Cancer Research Fund Twenty seventh Annual Report, 1928-1929 Pp. 18 (London)

Quarterly Journal of the Royal Meteorological Society Vol 55, No 232, October Pp 323 418 (London Edward Stanford, Ltd) 7s 6d

Department of Scientific and Industrial Research Building Science Abstracts, compiled by the Building Research Station and published in conjunction with the Institute of Builders Vol 2 (New Series), No 10, October Abstracts Nos 1983 2218 Pp v+351 386 (London H M Stationery Office) 9d net

Seventeenth Annual Report of the Director of the Solar Physics Observatory Pp 4 (Cambridge)

Livingstone College Annual Report and Statement of Accounts for the Year 1928-29 Pp 24 (London Leyton, E 10)

Journal of the Indian Institute of Science Vol 12A, Part 13 1 Amylase from Zea mais, by Vinayak Narayan Patwardhan, 11 Enzymes from the Seeds of Caesalpinia bonducella, by Vinayak Narayan Patwardhan Pp 185 192. (Bangalore) 8 annas

Commonwealth of Australia Council for Scientific and Industrial Research Bulletin 43 The Bionomics of Fasciola hepatica in New South Wales and of the Intermediate Host, Limnea brazieri (Smith) By I Clunies Ross and A C McKay Pp 62 Pamphlet No 13 The Mechanical Analysis of Soils. By C S Piper and H G Poole Pp 19 (Melbourne H J Green)

Report of the 7th Congress of the Far Eastern Association of Tropical Medicine, British India, December 5th, 10th, 24th, 1927 Pp iii+198 (Kasauli Central Research Institute)

The Journal, Hyderabad Geological Survey Vol 1, Part 1 1 The Annual Report for 1337 F of the Geological Survey Department, H E H the Nizam's Government, with Maps and Sections, 11 A History of the Golconda Diamond Mines, compiled from all available Sources with Maps and Appendices, together with a Reprint from the Transactions of the Royal Society of a Paper read in 1677 by the Rt Hon the Earl Marshall of England Pp x+62 (Lingsuggur Hyderabad Geological Survey) 2 8 rupees

The Ninety sixth Annual Report of the Royal Cornwall Polytechnic Society New Series, Vol 6, Part 3. Pp xxvi-xl+187 312+14 (Camborne) 5s

FOREIGN

Department of the Interior U S Geological Survey Professional Paper 154 A Moraines and Shore Lines of the Lake Superior Region By Frank Leverett Pp iv+72+8 plates (Washington, D C Government Printing Office) 50 cents

U S Department of Commerce Bureau of Standards Bureau of Standards Journal of Research, Vol 3, No 3, September R P No 99 Thermoelectric Temperature Scales, by William F Roeser, R P No 100 Light Fastness of Lithographic Ink Pigments, by William D Appel and Robert F Reed, R P No 101 Effect of Oxidizing Conditions on Accelerated Electrolytic Corrosion Tests, by Henry S Rawdon and W A Tucker, R.P No 102 Representation of Aberration Diffraction Effects by means of Rotating Sectors, by A H Bennett, R P No 103 Hot Aqueous Solutions for the Quenching of Steels, by H J French and T E Hamill, R.P No 104 Preparation of Experimental Saggar Bodies according to Fundamental Properties, by R A Heindl and L E Mong; R P No 105 A Suppressed Zero Electrodynamic Voltmeter, by F. K Harris, R P No. 106. Two Isomeric Crystalline Compounds of d mannose with Calcium Chloride, by J K Dale, R P No 107 A Study of Purified Wood Fibres as a Paper making Material, by Royal H Rasch Pp 343 506. (Washington, D.C. Government Printing Office)

Ministry of Finance, Egypt. Coastguards and Fisheries Service Report on the Fisheries of Egypt for the Year 1927 By El Miralai Ahmed Fouad Bey Translated from the Arabic by Selim Eff. Khoury Pp. vii+38 (Cairo. Government Publications Office) 5 P T

Bulletin of the American Museum of Natural History Vol. 58, Art. 11: A Collection of Brachyuran Crustacea from the Bay of Panama and the Fresh Waters of the Canal Zone. By Lee Boone Pp 561-583 (New York City)

Department of the Interior Bureau of Education. Bulletin, 1929, No. 22: Secondary Education By Carl A Jessen. Pp 19. (Washington, D.C.: Government Printing Office) 5 cents

U S Department of Agriculture Technical Bulletin No 137 The Pandora Moth, a Periodic Pest of Western Pine Forests By J E Patterson Pp 20 5 cents Technical Bulletin No 138 Studies on the Fall Army Worm in the Gulf Coast District of Texas By R A Vickery Pp 64 10 cents (Washington, D C Government Printing Office)

Scientific Papers of the Institute of Physical and Chemical Research No 207 The Angular Intensity Distribution of Continuous X ray Spectrum By Y Sugiura Pp 251 290 65 sen Nos 208 213, 208 Über die Alkalicellulose und deren Bedeutung auf die Herstellung der Kunstseide, von Gen itsu Kita und Ichiro Sakurada, 209 On the Development of Experimental Methods in Photo Elasticity, by Ziro Tuzi, 210 Photo Elastic Study of Stress Distributions in the Side Framing of Steel Car, by Ziro Tuzi, 211 Mechanical Properties of Snow Layer, by Masao Kuroda, 212 A New Design of Cathode Ray Oscillograph and its Applications to Piezo Electric Measurements, by Shumpei Watanabe, 213 Study on Impact Test by Means of Piezo Electricity and Cathode Ray Oscillograph, by Shumpei Watanabe Pp 112+14 plates 2 20 yen (Tokyo Iwanami Shoten)

Publikationer og mindre Meddelelser fra Københavns Observatorium Nr 65 Formeln zur genaherten Störungsrechnung in Bahnelementen Von Bengt Strömgren Angewandt auf die Planeten 633 Zelima, 950 (1921 IW), 979 Ilsewa, 1031 Amata und 1049 (1925 RB), von O Møller Nielsen und E Laursen Pp 26 (København)

Collection des travaux chimiques de Tchécoslovaquie Rédigée et publiée par E Votoček et J Heyrovský Année 1, No 11, Novembre Pp 571 626 (Prague Regia Societas Scientiarum Bohemica)

University of Illinois Engineering Experiment Station Bulletin No 196 An Investigation of the Friability of Different Coals By Cloyde M Smith Pp 50 30 cents Bulletin No 197 A Study of Fatigue Cracks in Car Axles Part 2 A Report of an Investigation conducted by the Engineering Experiment Station, University of Illinois, in co operation with the Utilities Research Commission By Prof Herbert F Moore, Stuart W Lyon and Norville J Alleman Pp 30 20 cents (Urbana, Ill)

CATALOGUES

South Africa Books, Prints, Paintings and Manuscripts (Catalogue 520) Pp 32 (London Francis Edwards, Ltd)

Respiration Apparatus designed by Dr E Simonson Pp 8 (Berlin Friedenau Askania Werke A G)

Catalogue of First and Early Editions, mainly of 19th and 20th Century Authors (No 337) Pp 134 (Cambridge W Heffer and Sons, Ltd)

Christmas Catalogue a Selection of Books suitable for Presentation Pp 16 (London Francis Edwards, Ltd)

First Editions of English Literature the Nineteenth Century to the Present Day (Catalogue No 522) Pp 56 (London Francis Edwards, Ltd)

Zeiss Field Glasses (T 380e) Pp 54 (London Carl Zeiss (London), Ltd)

## Diary of Societies.

*FRIDAY*, DECEMBER 13

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botany Lecture Room, Imperial College of Science and Technology), at 2 30 —Prof E S Salmon F R Petherbridge, M H. Moore, and others Discussion on Apple Scab, its Incidence and Control

BIOCHEMICAL SOCIETY (at St Bartholomew's Hospital), at 3 P M —H E Archer and G A Harrison The Effect of Reaction on the Heat Test for Bence Jones' Proteinuria —W H Hurtley · Notes on the Determination of Iodine in Blood, etc —K V. Thimann The Precipitation of the Basic Amino acids of Proteins by Phosphotungstic Acid —M J Rowlands and B Wilkinson Vitamin Content of Grass Seeds in Relationship to Manures —A. G Norman The Biological Decomposition of Plant Materials —D R P Murray and C. G King. The Stereochemical Specificity of Esterases —H Chick and M H Roscoe Stability to Heat of Vitamin $B_2$ (Anti dermatitis, Anti pellagra).—F K Herbert and M C. Bourne The Non Glucose Reducing Substances of Blood, with Special Reference to Glutathione.—B W Town · Isolation of Isoleucine from Gliadin —H G Reeves and E T Renborn. Some Properties of Dihydroxyacetone —J M Gulland and R A. Peters Observations on the Reducing Substances in Avian Blood — G Graham The Presence of Homogentisic Acid in the Blood of Patients with Alkaptonuria

DIESEL ENGINE USERS' ASSOCIATION (at Caxton Hall), at 3.30.—W Grose: A Form of Coupling for Geared Diesel Engines for Land and Marine Purposes

ROYAL ASTRONOMICAL SOCIETY, at 5 —A. N Brown · Observations of (Ch 678) U Persei, 1924-29 —E A Kreiken The Distribution of the Double Stars along the Giant Series.—J. G. Hagen · On the Significance of Baxendell's Nebulosity.—H G Tomkins Three Features of the Lunar Crust, from Photographs taken at Dedham — Dr H. Spencer Jones and J W. Jackson Stellar Parallaxes Determined Photographically at the Cape Observatory (2nd list).—W S Franks. Visual Observations of Dark Nebulae

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section) (Clinical Meeting, at Royal London Ophthalmic Hospital), at 5.

PHYSICAL SOCIETY (at Imperial College of Science and Technology), at 5 —J H Awbery and Dr Ezer Griffiths Apparatus for Determining the Specific Heat of a Material in Powder Form —Dr W E Deming: On the Determination of the Parameters in an Empirical Formula — N S. Alexander: The J Phenomenon in X Rays

INSTITUTION OF ENGINEERING INSPECTION (at Royal Society of Arts), at 5 30 —Capt. B. H Peter The Trend of Development in Railway Signalling.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5 30.

MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6

INSTITUTION OF MECHANICAL ENGINEERS, at 6—Prof G F Charnock Bearings for Power Shafting

TEXTILE INSTITUTE (London Section) (at Chemical Society), at 6 45—A E Woodhead Commercial Application of the New Esterified Cotton Fibres

INSTITUTION OF LOCOMOTIVE ENGINEERS (North Eastern Centre) (at Hotel Metropole, Leeds), at 7—W Hargreaves Safety Valves

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7—Dr Stern Fastness to Light—C D O Winslade Some Aspects of Colour Testing

MANCHESTER ASSOCIATION OF ENGINEERS (at Engineers' Club, Manchester), at 7 15—N. R Davis and C R Burch Electric Furnaces for Steel Melting

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Informal Meeting) (at Newcastle upon Tyne), at 7 15—E Wilson and others Is Sea Experience essential in order to become a Good Marine Engineer?

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at St Thomas' Café, Swansea), at 7 30—E A Tyler Further Notes on Pure Chemicals

JUNIOR INSTITUTION OF ENGINEERS (at Royal Society of Arts), at 7 30—Sir Ernest W Moir, Bart Some Engineering Difficulties and how they were overcome (Presidential Address)

LEICESTER TEXTILE SOCIETY (at Victoria Hall, Leicester), at 7 30—E J Spurr The Dyeing and Finishing of Hosiery Fabrics

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7 30—Prof F C Lea Physical Testing

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND, at 8—Dr L H Lampitt The Chemist and Commerce (S M Gluckstein Memorial Lecture)

EUGENICS SOCIETY (at Linnean Society), at 8.—Prof S J Holmes General Morbidity

ROYAL INSTITUTION OF GREAT BRITAIN, at 9—Miss D. A E Garrod Cave Excavation in the Near East

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (jointly with Manchester Literary and Philosophical Society Chemical Section) (at Manchester)—C Hollins Patent Law in Relation to the Dyestuffs Industry

*SATURDAY*, DECEMBER 14.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Newcastle upon Tyne), at 2 30—Papers open for further discussion—Burnt Outcrops of the High Main Coal at Newcastle on Tyne, R G Carruthers, The Distribution and Sequence of the Non Marine Lamellibranchs in the Coal Measures of Northumberland and Durham, Dr W Hopkins—To be discussed—Report of an Investigation of the Underground Conveying and Loading of Coal by Mechanical Means

BRITISH PSYCHOLOGICAL SOCIETY (Annual General Meeting) (at Royal Anthropological Institute), at 3 30—Dr A F Shand The Trust of Love.—Dr Kardos Phenomenal Thing moments

PHYSIOLOGICAL SOCIETY (at St Thomas's Hospital Medical School), at 4—L E Bayliss and A R Fee: The Secretion of Urine from Innervated and Denervated Kidneys Perfused with the Heart Lung Preparation—J C Eccles and Sir C. S Sherrington An Improved Bearing for the Torsion Myograph—Sybil Cooper and J C. Eccles The Mechanical Response in the Isometric Twitch—A St G Huggett Respiratory Reflexes in the Fœtus—W A Osborne Intravenous Administration of Oxygen—L B Winter Lactose Excretion in the Puerperium and the Isolation of Sugars from Urine and Blood—E N Chamberlain The Effect of Endocrine Extracts on the Cholesterol Content of the Suprarenals—Prof R J S McDowall The Effect of Carbon Dioxide on Certain Reflex Activities—Prof J Mellanby: The Isolation of Prothrombase from Mammalian Blood—G F Marrian and Dr A S. Parkes The Relative Amounts of Œstrin Required to Produce the Different Phenomena of Œstrus—M Hill and Dr. A. S Parkes: Sensitisation of the Pregnant Uterus to the Action of Oxytocin by the Preliminary Injection of Œstrin—*Demonstrations*—Prof. H E Roaf. Is the So called Secondary Excitation of the Retina due to Stimulation of the Rods?—E M Landis and T Lewis: A Case of Raynaud's Disease Treated by Cervical Sympathectomy

*MONDAY*, DECEMBER 16.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Section—Informal Meeting) (at Loughborough College), at 7

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section—London), at 7—C G E Dahl Calculating Machines

INSTITUTION OF AUTOMOBILE ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7 30

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7 30—Dr H Norinder Surges and Over Voltage Phenomena on Transmission Lines due to Lightning and Switching Disturbances

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8—M H Baillie Scott and others Debate on Are Building Bye laws destructive of Rural Beauty?

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8 30—M A. Spender Further Work on the Great Barrier Reefs

ROYAL SOCIETY OF MEDICINE, at 8 30—Reception Commander L. C Bernacchi: Southern Polar Exploration

*TUESDAY*, DECEMBER 17.

ROYAL SOCIETY OF MEDICINE, at 5 30—General Meeting

INSTITUTION OF CIVIL ENGINEERS, at 6

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Associate Members' and Graduates' Section—Manchester and District Branch) (at Milton Hall, Manchester), at 7—F. G Rathbone Economy in Steam Plants.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—H. D. Babcock A Photographic Study of the Solar Spectrum in the Wave-length Region 10,000 to 11,000 A U—Projection of Films: Dr W. H. Wright: The Rotation of Jupiter—H Rosenberger: (a) Living Cells of Human and Animal Tissue, etc, (b) Colloids and their Behaviour—Dr. W. Clark. A Further Demonstration of the Kodacolor Process.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Broadgate Café, Coventry), at 7.15.—Mr. Clark: Modern Aero-engines.

SOCIETY OF CHEMICAL INDUSTRY (Yorkshire Section) (jointly with Institute of Chemistry—Leeds Area Section) (at Medical School, Leeds), at 7.15—Prof M J Stewart and others Discussion on Asbestosis and Silicosis

INSTITUTION OF AUTOMOBILE ENGINEERS (Wolverhampton Centre) (at Engineering and Scientific Club, Wolverhampton), at 7 30—J Wallace The Super Sports Motor Cycle

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7 30—J Small The Properties of an Air Steam Mixture as a Working Substance

BRITISH PSYCHOLOGICAL SOCIETY (Industrial Section) (Annual General Meeting) (at National Institute of Industrial Psychology), at 7 30, (General Meeting), at 8—Miss I Lorrain Smith, Miss Katherine Pollock, Dr H M Vernon, Major W S Tucker, and Dr M Culpin Symposium on Noise

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 30—L H Evans The Stress strain Diagram

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8 30—J P Mills A Tour in the Chittagong Hill Tracts

*WEDNESDAY*, DECEMBER 18

SOCIETY OF GLASS TECHNOLOGY (at Science Museum, South Kensington), at 2—J B Murgatroyd The Choice of Annealing Schedule for Commercial Glassware—L H Milligen The Strength of Glass containing Cracks—Dr J T Littleton and Dr F W Preston A Theory of the Strength of Thermally Toughened Glass

ROYAL METEOROLOGICAL SOCIETY, at 5—J Edmund Clark and I D Margary Floral Isophenes and Isakairs—Sir Gilbert Walker On the Mechanism of Tornadoes—E W Bliss A Study of Rainfall in the West Indies

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5 15

GEOLOGICAL SOCIETY OF LONDON, at 5 30—Dr F Walker The Geology of the Shiant Isles

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at 17 Fleet Street), at 5 30—A A Hughes Early Bell Founding

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W C 1), at 6 15—Mr Massé Carols (Lecture)

LIVERPOOL ENGINEERING SOCIETY (at 24 Dale Street, Liverpool), at 6.30—Capt. R S Capon Aircraft Performance

INSTITUTION OF ELECTRICAL ENGINEERS (Tees Side Sub Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.

INSTITUTION OF AUTOMOBILE ENGINEERS (Graduates' Meeting) (at Queen's Hotel, Birmingham), at 7 30—N Bland Front Wheel Drive

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub Centre) (at Royal Victoria Hotel, Sheffield), at 7 30—J F. Colquhoun Public Street Lighting, etc

FOLK LORE SOCIETY (at University College), at 8—H W Howes Some Functional Aspects of European Folklore

ROYAL MICROSCOPICAL SOCIETY, at 8—W Wall A Trifoliate Pedicellaria in *Echinus miliaris*—F V Welch A Microscope Lamp—J E Barnard Note on Dark Ground Illumination

*THURSDAY*, DECEMBER 19.

LINNEAN SOCIETY OF LONDON, at 5

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6—Lt Col S E Monkhouse and L C Grant The Heating of Buildings Electrically by Means of Thermal Storage—T G N Haldane The Heat Pump—An Economical Method of Producing Low Grade Heat from Electricity.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group—Informal Meeting), at 7—L Eveleigh The Zöechrome Process of Natural Colour Kinematography

INSTITUTION OF ELECTRICAL ENGINEERS (Hampshire Sub Centre) (at Municipal College, Portsmouth), at 7 30—G Shearing and Capt J W S Dorling Naval Wireless Telegraphy Communications

CHEMICAL SOCIETY, at 8.—Prof A Smithells, H Whitaker, and Miss T Holmes The Influence of Hydrogen and of Water Vapour on the Ignition of Carbon Monoxide—F H Burstall and Dr S Sugden The Parachor and Chemical Constitution Part XIV Tellurium Compounds.—K. A N Rao Studies in 'Strainless' Rings Part II The Effect of Transdecalin on the Carbon Tetrahedral Angle—J. N Ashley and C R Harington Synthesis of 1 2 thiol histidine—Prof F L Pyman: 2 Thiol 4(5) β aminoethyl Glyoxaline (2 thiolhistamine)

INSTITUTE OF RUBBER TECHNOLOGISTS (at Manchester Café, Manchester).—Papers on Reclaimed Rubber

*FRIDAY*, DECEMBER 20

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Informal Meeting), at 7—Determination and Isolation of the Picture

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7 30—W. Challis: Line Signalling on the Southern Railway

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr E Cammaerts Italian and Flemish Art: A Contrast.

## PUBLIC LECTURES.

*SATURDAY*, DECEMBER 14

HORNIMAN MUSEUM (Forest Hill), at 3 30—Miss M A. Murray Witchcraft

*MONDAY*, DECEMBER 16.

UNIVERSITY OF LEEDS, at 5 15.—J. Gray: Ciliary Movement.

*TUESDAY*, DECEMBER 17

CARDIFF TECHNICAL COLLEGE, at 7 30—W. S. Vernon. X Rays

*WEDNESDAY*, DECEMBER 18.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Prof. E. L. Collis: Industry in Relation to Personal and Public Health.

SATURDAY, DECEMBER 21, 1929.

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No. 3138, Vol. 124]

## The National Museums and Education.[1]

TO-DAY, as at no past period in the history of the museums of Great Britain, active and enlightened minds are applying themselves to review the accomplishments of these institutions and to devise means for their greater participation in the life of the nation In endeavouring to interpret the 'new museum outlook' which loomed through this outburst of interest, we alluded in a leading article in NATURE (June 29, 1928) to a museum feeling in the air Fresh and welcome evidence of this spirit is afforded by Part 1 of the Final Report of the Royal Commission on National Museums and Galleries, to which references have already been made in our columns.

The whole field of museum activity in Great Britain has now been covered The Carnegie United Kingdom Trustees, through Sir Henry Miers, surveyed the land of the provincial museums, and they found a desert, brightened, it is true, by occasional oases, but nevertheless an arid country which could be made fruitful only by an infinitely patient and plenteous irrigation, some of the streams whereof must be of pure gold The Royal Commission, facing another quarter, has looked upon the great institutions where are housed the nation's treasures, and although barrenness is here replaced by a certain amount of jungle growth—for the golden streams have been running steadily if not copiously for many years—yet here also is envisaged in the near distance a land of promise towards which the museums must strive.

This section of the Final Report embodies the general conclusions and recommendations of the Commissioners; a second section to be issued at an early date will contain the findings relating to individual institutions While the latter, therefore, will fix the milestones along the highway of museum progress, to the former we look for the finger-posts pointing the general direction of advance and indicating the objective of the museum body as a whole. Three big problems are involved in any forward movement—the inter-relationship between the national museums and galleries themselves, the relationship of the national institutions to similar provincial bodies, and the share to be taken by the national institutions in education. This last lies at the very heart of the matter, and its proper solution can be the only means of

[1] Royal Commission on National Museums and Galleries. Final Report, Part 1. General Conclusions and Recommendations, dated 20 September 1929 (Cmd. 3401.) Pp. 93 (London. H.M. Stationery Office, 1929) 2s. net

enabling the museums to play their due part in the life of the nation.

That lack of vision of the educational possibilities of museums and galleries which appears to be characteristic of British administration is painfully evident in the terms of reference set for the guidance of the Commission Education is mentioned there only once, and with a negative emphasis which does not make for encouragement —" to consider in what way, if any, expenditure may be limited without crippling the educational and general usefulness of the Institutions "—and not in all the eight instructions is there a word to suggest that in the possibility of creating new contacts with childhood, youth, and manhood, might be a field worthy of the closest inquiry

The Commission, however, has been bolder than its mandate, and appreciating that " the National Museums and Galleries are *essentially educational institutions* ", makes many suggestions the adoption of which would add to the teaching efficiency of the institutions. It cannot be said, however, that the attainment even of these suggestions will bring the educational facilities of British museums within measurable distance of those already in full force in the museums of the United States of America, to which we have made favourable reference again and again in the pages of NATURE. To take one example · the report, in recording certain outstanding deficiencies in the national museum service of Great Britain, suggests the creation of a museum of ethnography, a museum of casts, a folk museum, and an Oriental museum, but there is no hint of a prospective children's museum, such as that which has been so successfully developed at Brooklyn, New York Yet it is obviously unfair to expect children, though they do their best, to grapple with exhibits arranged and labelled for adults.

Part of the present-day deficiency in the educational organisation of museums and the like is undoubtedly due to that lack of vision which is apparent in the terms of reference. Whilst the stock educational bodies have advanced relatively by leaps and bounds, the museums stand still. The report reveals the insufficiency with unanswerable statistics :

" For the last twenty-five years, the development of the National Institutions measured in terms of State support has advanced hardly at all as compared with the development of elementary education, secondary education, or university education. The exchequer expenditure in respect of these three forms of education in England and Wales has in this period increased approximately as follows · elementary education threefold. secondary education and technical education eightfold: university education nineteenfold In the case of National Museums and galleries expenditure has increased twofold · in other words, taking account of the change in the value of money, it has almost stood still . It seems to us that so great a disparity is an indication not only of a lack of appreciation of the purpose of these Institutions, but of a definite defect in the relations between them on the one side and governmental authority on the other "

To three main lines of development the Commissioners look for increased efficacy in the spread of knowledge: the enlargement in scope and improvement in quality of circulating collections, the more effective display of exhibits, and improved methods of contact with the public. We cannot follow here the recommendations in detail, but we note that while the further development of the loan system of the Victoria and Albert Circulation Collection to schools of art, secondary schools, and training colleges is contemplated, no suggestion is made of participation in these great privileges by elementary schools, although the success of the system organised by the great American museums rests on this lowly basis. Nor is it quite clear that natural history material is to be included in the enlarged Victoria and Albert central circulating agency, though experience elsewhere has shown that the circulation of life-histories and natural groups of common creatures and plants is perhaps the best appreciated of all the activities of museums in relation to school work, and although the Commission views with favour the ultimate circulation of natural history and other scientific objects

It need scarcely be said that much could be done in existing space to improve the appeal and the teaching quality of exhibits. We are reminded of the comment of a young German friend, familiar with the Deutsches Museum in Munich and the other great German institutions, who after a visit to London a month ago, remarked that one of the leading museums there was more like an antique shop than a museum.

A great future lies in the tightening up of contact with the people. Better publicity, publications with a popular appeal, the development of the guide-lecturer system, lecture theatres and evening lectures, are some of the most obvious methods. The report passes lightly over the question of the inadequacy of the present staffs of the national institutions to carry out the many reforms that are foreshadowed and are indeed long overdue. It suggests the appointment in the larger institu-

tions of a whole-time officer whose duty it would be to keep contact between the public and officials We doubt if this step, progressive though it is, would meet the case, and we look further to a closer *rapprochement* between education authorities and museums, and the consequent delegation of teachers wholly set aside for the conduct of school classes in museums, for the foundation of that close contact which alone can bring the nation's treasure-houses of art and science adequately into the educational life of the day

## Aviation and the Future.

*The World, the Air and the Future* By Comdr Sir Charles Dennistoun Burney Pp xxiv + 356 + 24 plates. (London Alfred A Knopf, 1929) 21*s*

THE vast significance of air transport to civilisation in general and to the British Empire in particular has as yet been appreciated by comparatively few That Britain, which of all nations is the one most called upon to lead the way in the use of this wonderful instrument for linking the world together in peace and prosperity, should have fallen so far behind others, in particular the United States and Germany, in civil aviation developments as to be no better than third-rate, is little short of a tragedy.

Those who have realised this regrettable state of affairs have impatiently awaited a book that would enable the thinking man to appreciate the deep significance of air transportation for us in the progress of mankind. It is to Commander Sir Dennis Burney that we are indebted for the first real attempt to write such a book. The subject is big and contains many difficult problems, but, although some of his arguments and assertions may be subject to criticism, the main principles, propounded with marked sincerity and courage, may be expected to survive

To all men, especially to men of science and men of commerce, it is increased *speed of communication*, whether by personal contact or by written document, that is daily in greater demand. It makes co-operation more effective and increases efficiency by enabling more work to be done in a given period of time, quicker contact to be established with minds in distant lands, and a better use to be made of leisure time. Air transportation, whether we like it or not, has arrived to impart this acceleration to our lives.

At present, aviation is in its infancy and its teething troubles must be recognised as such. It is as ridiculous to point to the present limitations of aircraft and their operations and to the relatively high cost of air travel as an argument that they cannot be of any commercial use, as to say that a child which cannot work efficiently and pay its own way will never do so There is a tendency to ignore the fact that there already exist air services which, due to special conditions, pay their way handsomely, and each day progress is made towards the establishment of economically run services where conditions are not so favourable

The construction and mechanism of aircraft require the attainment of the highest perfection, and therefore their successful economic development will depend to an exceptional extent on the application of the results of the research work at present occupying the attention of several branches of science It thus appears probable that the attainment, not perhaps of vastly higher speeds, but at least of the greater efficiency we require, is likely to be a very rapid process

Just as the coming of the steamship, the railway, and the motor-car completely changed the life of each nation into which they intruded, so will aircraft entirely change the character and mode of life of the world. Whereas in the past the units influenced have been separate nations, in the future there will be but one unit—the world. Aircraft, in other words, will, by the nature of the operations, render all obstacles to free movement about the world at a speed of 100 m.p.h or more, so objectionable, that the force of international public opinion will sweep aside all national barriers and other man-made obstructions Aircraft "are going to create the conditions of their own development Indirectly, and without altogether realising it, they will dictate policies, transform issues, solve old problems in a new way, and bring important new changes into the psychological structure of human society."

Can we possibly doubt the far-reaching effect this will have on the human race? On the contrary, it is clear that we are indeed witnessing the beginning of a new phase in our evolution. It is perhaps prophetic that at a time when the world is struggling to free itself from the tangles of numerous man-made restrictions which prevent humanity moving on to a higher plane, this mode of locomotion in that free, universal medium, the air, should have appeared to aid it. Flight implies something more than an extra rapid means of transport; it implies a new framework in the mind, a new mental outlook affecting all our thoughts and activities.

No one who reads this book by Sir Dennis Burney can fail to recognise this new outlook The mental shock experienced by the realisation of the great changes that are impending will be stimulating or unpleasant according to the temperament of the percipient. It may be said that the change from surface transport to air travel is as big a leap, when considered in its psychological effect on the ordinary man, as that which the mathematician faced in the acceptance of Einstein's theory of relativity. In each case a dimension has been forced on the attention of unwilling recipients in a manner extremely disturbing to complacent minds

The remarkable thing about aviation is that it contains such vast potentialities for the solution of each of four of the most vital problems we have to face to-day, namely :

(1) *Commercial Efficiency*.—The saving of time over long distances enables a business man, his correspondence, his samples, his contracts, and his money to act more quickly and go farther afield. Air transport will therefore be of prime importance to commercial prosperity.

(2) *Empire Development*—The ability of aircraft to cover ground quickly enables even difficult countries to be easily and quickly surveyed and exploited, enables large areas to be efficiently inspected and controlled at low cost, and keeps the pioneer workers at the outposts of the Empire within easy reach of civilisation.

(3) *Imperial Solidarity and Security*.—The essential for all work of Imperial co-operation, both in peace and war, is rapid and efficient co-ordination and intercommunication Air transport, by minimising large distances (in terms of travelling time), will draw the Empire together and thereby secure a better understanding and increased co-operation. Moreover, effective Imperial defence at present depends primarily on the security of England, and that is essentially an air matter and requires an air-active nation to support it.

(4) *International Peace*—The ultimate establishment of a peace psychology throughout the world rests on the attainment of a better understanding between the peoples of the different nations and on the recognition of mutual cultural values. Only by a greatly increased intermixing and intercommunication of the peoples can this be brought about. Air transport, by its international nature, and by its impatience of all obstacles that prevent rapid travel, will assuredly achieve this in the end.

Sir Dennis Burney has a great deal to say about all these subjects in the first four chapters of his book The problems of Imperial defence are dealt with at great length, and he shows that, although in the main they are naval problems, the defence of Great Britain is an air problem. Not only, therefore, is a complete re-orientation of naval policy required, but also a reserve of civil pilots and of aircraft manufacturing power as an essential support for our small air force Such an economic reserve can only be built up by the expansion of civil aviation both at home and in the Empire

Sir Dennis makes no demands for increased armaments ; on the contrary, the chapter on international peace is a strong plea for an organised move towards peace and for the exploitation of this inherent ability of air transportation to bring nations together In the end, aviation must be made international, and will thus help to ensure the peace of the world

The second half of the book is devoted to a discussion of the technical capacities of different kinds of aircraft and their probable future development. In Sir Dennis's view, the airship will be the vessel for trans-oceanic flights, while the flying boat already shows great promise for long-distance coastal routes and is capable of development to a far greater size than the aeroplane

The chapter on airships, which received undue prominence in the daily Press, will naturally be of interest to all readers It was never claimed that *R100* and *R101* would be anything but experimental, and already it appears that the expenditure on this experiment, in view of its Imperial importance, has been justified by the knowledge gained Sir Dennis Burney admits that he has changed his mind regarding certain aspects of the airship problem, that he underrated the difficulty of handling and mooring such large ships, and that for commercial operation a higher cruising speed, namely, 90 m p.h., is essential. He offers, however, ingenious solutions for the problems : first, a mechanically operated mooring and docking raft; and secondly, the use of fuel-gas engines more efficiently disposed on the ship. He also advances a completely new solution in his proposed elliptical airship, which he claims would be capable of landing on any sheltered waters and of mooring like a marine vessel.

The book concludes with a chapter of constructive proposals for the international organisation of flying and for Empire air development. A revision is suggested of the Imperial defence policy which will save such a sum that £10,000,000 could easily be set aside annually and devoted to the adequate expansion of civil aviation.

The reader may ask, What is the standing of Great Britain and the Empire in the air developments of to-day? The answer is that while our men of science and our craftsmen have left us technically unsurpassed, we occupy an altogether inferior position in the air commerce of the world. We have lost aircraft markets we might have obtained and the development of our Imperial and international air routes, though sound, has been so hopelessly slow that in the amount of scheduled commercial flying we stand to-day no better than a bad fourth on the list; the United States, Germany, France, and possibly Russia, are more active than we. These nations pay large subsidies, either directly or by mail contracts, in order to develop and secure in advance a stake in the great future that is coming to aviation. Great Britain, the transport nation of the world, spends a negligible amount on this new form of transport, and is thus failing to secure her share of what is destined to be more vital to her than to any nation in the world.

There is great work to be done in rousing the nation to a realisation of the great world-wide opportunity it is neglecting, and of the fact that the future security, prosperity, and prestige of the Empire is being jeopardised by our apathy. It is a hopeful fact that there is a body at work to bring this knowledge to the people, namely, the Air League of the British Empire (Astor House, Aldwych, London, W.C.2).

Sir Dennis Burney is to be congratulated on completing so successfully a pioneer book, a book of vision, on matters of such vital significance to us all. It cannot fail to interest everyone who wishes to see the British Empire retain a leading part in the progress of human evolution. G. Merton.

## Persuasion and Belief.

*Phantom Walls*. By Sir Oliver Lodge. Pp. 251. (London: Hodder and Stoughton, Ltd., 1929.) 5s. net.

THIS volume is a sketch of Sir Oliver Lodge's well-known theories concerning the universe, man, survival, and immortality. There would not appear to be anything new in his treatment of these matters in the present work; rather is it intended for a different type of audience. For on examination, it seems that the book is primarily put forward as a persuasive essay to be read by those who, for whatever cause, are forsaking organised religions and embarking independently in their quest for truth. As a handbook of spiritualism for the bereaved person or for the perplexed cleric the book is admirable; as an exposition of the same theme for the unemotional and critical man of science, it is not altogether convincing.

Sir Oliver sets out by remarking upon the gradual secession of educated people from the churches, but "the instinct for worship" which he believes man to possess prevents him from becoming altogether divorced from spiritual realities. Hence, if through spiritualistic manifestations it can be shown that man survives bodily death, then the instinct for worship can be given full play, fortified by the assurance that the saints and great men of the past still live and still struggle for the elevation of the race, although, like ourselves, subject to a Higher Power which "guides humanity in some far seen and hopeful direction".

Now Sir Oliver has received, it seems, indubitable proof of the persistent continuity of individual personal existence. Therefore it behoves him to explain to those who have not been granted this knowledge how the fact of survival can be reconciled with physics and psychology, with biology and evolution. The first thing to understand is that the brain is merely the organ of the mind. Thought is no more in the brain than music is in the violin. The mind cannot be damaged by a brick-bat; only the instrument through which it manifests can thus be destroyed.

This hypothesis opens up the attractive idea that minds can manifest themselves when they possess the appropriate instruments. On earth they make use of material brains, and then only for a short time; but, according to Sir Oliver, the earth life is an exceptional thing. We are spirits temporarily incarcerated in matter and we are more at home in the spirit world than we are here (p. 100). Moreover, even imprisoned as we are in matter, the reality of the spirit world is often borne in upon us. Such phenomena as veridical dreams, 'direct' voices, premonitions, and trance lucidity are indications of its existence, and the so-called cross correspondences are full of almost incontrovertible evidence. Personality survives bodily death: the mind functions by means of another instrument after the brain has long crumbled to dust. This theory of *personal* survival relieves us of having to accept the idea that all living things survive and permits us at the same time to grant survival to domesticated pets and other creatures which exhibit signs of conscious striving for unrealised ends (p. 75). Indeed, the chance of survival appears to depend upon the growth of the neopallium through which those elements may function which are worthy of a continued existence.

It is true that Sir Oliver sees a few of the difficulties in the way of accepting his theories of man's destiny But the new outlook in physics is in no wise antagonistic Science, it seems, is becoming idealistic and bio-physics is beginning to investigate the interaction of life and matter Indeed, simple ideas are tending to clarify what were at one time momentous problems Such questions as those concerning prayer and miracles can best be understood by an argument from the lower animals To the cat which wants the door opened, the man who obliges is a higher being, and we are able to perform similar services to bees and birds when trapped in closed rooms Difficulties vanish when one thinks of them as the lower and ourselves as the higher beings.

The spiritistic hypothesis solves many of the difficulties of man's life and ultimate destiny. Undoubtedly, as Sir Oliver points out, it is somewhat hard to formulate in a precise and scientific manner. It is, he says, "an appeal to the activity of unknown agents, acting by unknown methods, under conditions of which we have no experience, and by means of which we are unaware" (p. 209). Indeed, it does not sound very hopeful—or helpful.

## A Bibliography of Applied Science.

*Mededeelingen van het Nederlandsch Instituut voor Documentatie en Registratuur.* No. 6, 1928, 10/12. Pp. 2073-2249. (Amsterdam: Nederlandsch Instituut voor Efficiency, 1929.) Bi-monthly, £2 10*s.* a year.

THIS unassuming but extremely valuable publication is the descendant of the "Index of the Technical Press" which was commenced in 1903 by the International Institute of Bibliography at Brussels to supply the need for a comprehensive bibliography of applied science. The "International Catalogue of Scientific Literature" had recently been started on the domain of pure science, and the "Index of the Technical Press" was intended to cover the ground on the applied side. Afterwards the title was changed to "Revue de l'Ingénieur et Index technique". The present publication was commenced in 1922 by the Dutch Institute of Documentation under the auspices of the Institute.

The series from 1903 to the present date is the only comprehensive bibliography devoted to the various aspects of the application of science to industry, and is undoubtedly of the greatest value as an index to the literature of applied science. The current volumes contain some sixteen thousand entries a year and relate to such subjects as hygiene, testing materials, steam engineering, electrotechnics, electric generation and transmisson, telegraphy, radio communication, mechanical engineering, civil engineering, railways, hydraulic engineering, transport, aviation, agriculture, industrial organisation, chemical technology, fuels, gas and oil technology, mining, heating and lighting, ceramic industries, dye manufacture, paints and varnishes, metallurgy, paper making, textile industries, rubber industries, building construction, photography, etc.

The entries are printed in type script in two columns on one side of pages of quarto size and classified by the Universal Decimal Classification of the International Institute of Bibliography, which is now rapidly coming into use as standard international classification In addition to the classification numbers, which are printed at the beginning of each entry, the names of the main classes are printed at the heads of the pages, so that, by looking through the headings, a clue to the entries on a particular topic may be obtained without consulting the tables of the classification. As a further convenience, a dotted line is printed at the end of the entries in each class. This makes it unnecessary to read the classification number at the head of each reference, when once the appropriate division has been found It is intended that the bibliography should be cut up, mounted on cards, and filed in arithmetical order of the classification numbers, so as to form a cumulative bibliography, in which all the references relating to a single subject fall together automatically as received. As, however, the pages are issued in loose leaf form, it is possible to file them, as received, in a single series under the classification number of the first entry on each page. This will serve to bring the entries on each subject fairly closely together.

The bibliography is really indispensable to scientific investigators, research associations, and all who need a ready means of gaining access to the literature of a technical subject. It is particularly useful to those who adopt the Decimal Classification for their own subject-matter indexes, as the mounted references fall naturally into place with all references classified on the same system, and in this way a very comprehensive bibliography of a special subject can be built up

It is unfortunate that the printing is poor. This is due to lack of support in the past. But, as the bibliography attains a larger circulation, it will be possible to improve the style. S. C. BRADFORD.

## Our Bookshelf.

(1) *Die Arithmetik in strenger Begründung.* Von Prof. Otto Hölder. Zweite Auflage. Pp. v+73. (Berlin: Julius Springer, 1929.) 3.60 gold marks.

(2) *Theory and Application of Infinite Series.* By Prof. Dr. Konrad Knopp. Translated from the second German edition by Miss R. C. Young. Pp. xii+571. (London and Glasgow: Blackie and Son, Ltd., 1928.) 30s. net.

(1) THIS little book gives a method of basing the theory of arithmetic on the properties of finite aggregates and on Dedekind's section. Prof. Hölder holds the view that an arithmetic founded solely on postulates and axioms must be insufficient, since even in this case series of operations must be counted.

(2) Prof. Knopp's book is beautifully printed and arranged. Of the three parts into which it is divided, the first begins with the theory of real numbers, the starting-point being an assumption of a knowledge of Hölder's arithmetic of rational numbers. From this point, Dedekind's theory of irrational numbers and the notion of convergent sequences are introduced. The second part discusses the foundations of the theory of infinite series, and the third part proceeds to modern developments. Here the author gives many valuable chapters, including an illuminating discussion of Fourier series. Chapter xiii. contains a very useful digest of methods for associating the notion of 'sum' with divergent series. Chapter xiv. on Euler's summation formula and asymptotic expansions has been specially written for the English edition. The author's aim has been especially to help the private student, and to this end many explanations of difficult points and apt illustrations have been included. The translation has been well done and there is an easy flow of the language.

In both the above books Dedekind's theory of irrational numbers has been adopted, presumably because of the uniqueness of their representation. But Cantor's theory lends itself more naturally to a simple detailed treatment, and, being fundamentally equivalent to Dedekind's theory, might with advantage have been used. L. M. M.-T.

*Geologie von Perú.* Von G. Steinmann. Mit Beitragen von R. Stappenbeck: *Nutzstoffe*; F. Sieberg: *Erdbeben*; C. Lissón: *Geologische Karte.* Pp. xii+448+9 tafeln. (Heidelberg: Carl Winters Universitatsbuchhandlung, 1929.) 28 marks.

THIS work by the veteran Prof. G. Steinmann gives an excellent summary of what is at present known of the geology of Peru. Unlike Bolivia, Chile, Colombia, and Venezuela, which were visited in the first half of the nineteenth century by D'Orbigny, Darwin, and Humboldt respectively, scarcely any investigations into the geology of Peru were made before the work of Raimondi, whose first publication appeared in 1862. The bibliography now given by Steinmann extends to 22 pages, but owing to the extent of the country and its climatic and physical characters vast tracts are still unknown or almost unknown geologically. Much of the knowledge we have is due directly or indirectly to the work of geologists who have been primarily concerned with the investigation of the mineral resources (gold, silver, zinc, copper, quicksilver, iron, nickel, cobalt, wolfram, antimony, petroleum, coal, etc.).

The account of the stratigraphy, tectonics, and geological history occupies nearly three quarters of the book, and is followed by a section on the mineral resources by R. Stappenbeck, and an account of the earthquakes of Peru by A. Sieberg. The geological record begins with the Archæan crystalline rocks, followed by the pre-Cambrian phyllites, the Middle and Upper Ordovician, the Lower Devonian, the Upper Carboniferous and Permian, the Trias, Jurassic, Cretaceous, Eocene, Miocene, Quaternary. The chief breaks in the succession are (1) between the Archæan and the phyllites, (2) during the whole of the Cambrian and probably Lower Ordovician, (3) during the Middle and Upper Devonian and Lower Carboniferous, and (4) between the Chalk and the Middle Eocene. The work is illustrated with numerous sections, and with reproductions of published figures of characteristic fossils. The map of the Cordillera, showing the distribution of the formations so far as known, has been prepared by Steinmann and Lissón.

*A Treatise on Pharmaceutical Chemistry: embracing certain Special Topics of Analytical, Organic and Physical Chemistry as they are related to Pharmacy.* By Dr. John C. Krantz, Jr. Pp. 282. (London: Henry Kimpton, 1928.) 15s. net.

IN this volume the author has selected certain subjects for special consideration. The work is divided into three parts: in the first, the quantitative estimation of certain inorganic elements, of pharmaceutical importance, either as remedies or impurities, is discussed; the actual methods are not always given in detail, but reference is made to the U.S. Pharmacopœia. The method and its theoretical implications are then submitted to discussion. The section is intended to serve as an illustration of the importance of quantitative methods for pharmacists. The second part is devoted to a consideration of the structure and methods of preparation of a number of complex organic compounds used in medicine, such as the hypnotics, local anæsthetics, antipyretics and bactericides, including the organic arsenicals. This section is useful for quick reference to the formulæ of a number of substances which are in everyday use. In the third part, there is a theoretical consideration, accompanied by illustrative experiments, of certain aspects of physical chemistry.

On the whole, this can be considered an advanced text-book, probably of greater value to the pharmaceutical research worker than to the student. For readers in Great Britain it suffers from the disadvantage that the possession of the U.S. Pharmacopœia is an essential prelude to its use. On the

other hand, the second and third sections should be of value to chemists and pharmacologists as well as to pharmacists.

*Palæontology* By Prof. Edward Wilber Berry. Pp xii + 392. (New York: McGraw-Hill Book Co, Inc.; London: McGraw-Hill Publishing Co., Ltd, 1929) 17*s* 6*d* net.

THE author, in his preface, describes the scope and intention of this book, which is to lay emphasis on one hand on the evolutionary story that the study of palæontology tells us, and on the other to illustrate the adaptation of animals to their environment. The author further states that his purpose is "to interest rather than to repel the beginner—a pedagogical principle all too frequently ignored". In these aims he appears largely to succeed, and the book compares well with others of its class Naturally, in a book which deals with the whole of palæontology from Protozoa to man in 364 pages, there must be either compression or omission, and the second alternative has wisely been chosen, with the result that the reader, who is supposed to be a beginner, is at all events saved from mental indigestion

Of the figures and diagrams, a good proportion, especially in the chapters on invertebrates, are the author's own, are refreshingly new, and remind the reader that extinct animals were once alive. In the various tables of affinity and descent a cautious position is held Here and there a captious critic will find that the author has not always been able to keep up with the flood of recent discovery, but from some slips and errors no writer of a text-book can hope to be free, and there is none that prevents the book from being recommended to a student as a jumping-off ground to larger and more detailed works

*Trailing the Giant Panda.* By Theodore Roosevelt and Kermit Roosevelt. Pp. xi + 278 + 33 plates. (New York and London: Charles Scribner's Sons, 1929.) 16*s*. net.

THE giant panda (*Æluropus melanoleucus*) is rather like a bear, with black spectacles, saddle, forearm, and quarters of dark brown, and the rest of the body white. He lives in steep bamboo jungle, on which he feeds, sleeps in a hollow tree, and ranks as a sahib because he does not cry when shot. No civilised man had ever seen him alive until the present authors tracked down an old male, with fatal results for the panda. Scarcely better known is the takin (*Budocras taxicolor*), half goat, half antelope. Very rare is the golden monkey. These and other rare species were the quest in a successful expedition, by the Bhamo route from Burma into the Chinese provinces of Yunnan and Szechuan, penetrating a wild region to northward of the Yangtze-kiang and leaving by way of Indo-China, a journey of about two thousand miles.

Among the numerous and excellent photographs is one of Mt. Koonka, mapped here by some optimist as thirty thousand feet high, pending more careful survey. The country as a whole, however, is unsurveyed, large parts of it unexplored by Europeans, although inhabited to the last possible limits of saturation, partly by Chinese, but mainly by semi-independent tribes, not always cordial to visitors The present work deals mainly with the adventure, but contains a great deal of interesting material, while the scientific staff, collecting for the Field Museum at Chicago, will doubtless publish their results through the usual channels

*The Biochemistry of the Amino Acids.* By Prof H H Mitchell and T S. Hamilton (American Chemical Society Monograph Series, No 48) Pp 619 (New York The Chemical Catalog Co, Inc, 1929) 9 50 dollars

IN this monograph the authors have given a detailed account of the chemistry and physiology of the amino-acids, their preparation, determination and properties, and the part they play in metabolism and nutrition They have examined the available evidence very critically, more especially in the physiological chapters, so that the work forms a very useful review of our present knowledge The fact that the monograph is of the size of many text-books of physiology indicates the extent of the literature dealt with. The chemical chapters account for about one-third of the volume the remaining two-thirds give an up-to-date account of the digestion of the proteins and the absorption of their constituent amino-acids, the catabolism of these compounds and their relationships with carbohydrate and fat metabolism, the breakdown of the individual amino-acids being considered in detail. Finally, there are chapters on their specific dynamic action, on the catabolism of tissue protein, and on the nutritive values of proteins and the protein values of foods in nutrition. The book will be of great use as a work of reference by research workers, and also to all advanced students of biochemistry and physiology.

*A Challenge to Neurasthenia.* By Doris Mary Armitage Pp. 52. (London. Williams and Norgate, Ltd., 1929.) 5*s*. net.

THIS book is principally an appreciation of the late Dr. L. S Barnes. It describes his attitude to neurasthenia and his method of treating the neurasthenic, which appears to have been by the application of his own strong personality in encouragement, coupled with an appeal to the patient's intelligence. Apart from the statement that Dr. Barnes considered all neurasthenic troubles to originate in fear, there is no indication of what he considered to be the etiology of functional nervous disorders. This defect, and a lack of detail regarding the line of treatment, will hamper other physicians attempting to follow the same method of psycho-therapy. The book does, however, encourage doctors to pay serious attention to the neurasthenic, and provided the tendency to regard the subconscious mind as a sort of separate personality is not taken too literally, it will also encourage patients to believe that neuroses are susceptible to treatment. It is a matter for regret that Dr. Barnes did not live to publish his own views on psycho-pathology and psycho-therapy.

## Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### The Earthquake South of Newfoundland and Submarine Canyons.

THE powerful earthquake south of Newfoundland which, on Nov. 18 and 19, broke eleven submarine cables in at least twenty-three places and devastated the southern coast of Newfoundland, promises important evidence as to the nature of the submarine canyons off the Atlantic coast of Canada and the United States. The earthquake was obviously of the highest order of intensity at its centre, for it overthrew chimneys, and was therefore of the order of over No. 7 on the Rossi-Forel scale in the towns of Nova Scotia, more than 400 miles from its origin, and it occasioned a tsunami or earthquake wave, which drowned 26 people on the Burin Peninsula in Newfoundland, did extensive damage to property, and in places swept inland to the height of 100 feet.

The accompanying sketch map (Fig. 1), based on one kindly supplied by Mr. L. Robinson of the Western Union Telegraph Co, and on a list of seven breaks on the cables of the Commercial Cable Co, by Mr. R. J. Hughes, shows that the breaks are mainly in two roughly parallel lines in continuation of the trough-like valley, in places 285 fathoms deep, through Cabot Strait. The lines are not fully straight; but as the positions of the fractures are based on tests from the shore-ends, they may not be exact, as they may be displaced by strains or injuries to the cable outside the main fractures.

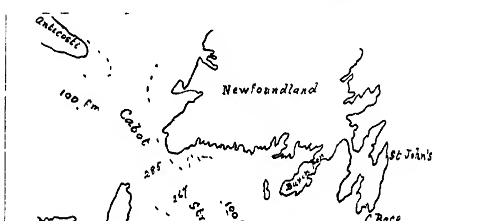


FIG. 1.—Sketch map of the Cabot Strait earthquake, Nov. 18–19, 1929.
The thin lines represent the twelve broken cables: the cross bars the approximate positions of twenty three fractures.
The dotted area represents the probable foundered band in continuation of the Cabot Strait.
‡ Approximate position of the *Caledonia* when violently shaken by the earthquake.
The devastation on the coast of Newfoundland was mainly near the Burin Peninsula.
Depths in fathoms.

Eleven of the twelve damaged cables have two fractures apiece, at the distance of usually from 80 miles to 150 miles apart. The positions are roughly in two lines, which continue the straight steep side of the trough of Cabot Strait. That trough is up to 285 fathoms deep and trends from north-west to south-east. The earthquake appears to have been due to a renewed subsidence on the submarine southern continuation of Cabot Strait, though the trend bends to south south-east. The depths along the middle of this sunken bend were 1750, 2332, 2680, 3450, and 2934 fathoms, and the depth is usually hundreds of fathoms greater than in the area on either side. The earthquake is probably due to a fresh subsidence of the floor of this submarine rift valley.

The new evidence throws light on the nature of the famous submarine canyon of the Hudson River off New York, which makes a notch in the 100 fathom line by a depression 2400 feet deep. The buried channel inland is known to be in places bounded by faults.

The St. Lawrence Valley has been interpreted as a strip sunk between parallel faults by Mgr. Laflamme (*Trans. R. Soc. Canada*, ser. 3, vol 1, 1908). Its tributary, the Saguenay fiord, the site of the powerful earthquake of February 1925, the latest of the violent shocks of the Charleston—New England—St. Lawrence series, is probably due to subsidence as its bed is in places 140 fathoms below sea-level. It trends approximately east and west in line with the pivotal line across Newfoundland.

Such submarine canyons have been attributed to four processes: to excavation by rivers when the land stood thousands of feet higher than at present; to the power of glaciers to excavate troughs deep below sea-level; to the accumulation of sheets of sediment on either side of a channel kept clear by currents, as suggested by Darwin for the canyons of the Blue Mountains in New South Wales, and by J. Y. Buchanan for the submarine canyon off the Congo. The fourth explanation is that they, like fiords, are due to the subsidence of strips of land along faults; that conclusion, advanced in "The Nature and Origin of Fiords" (1913) appears strongly supported by the evidence of this new earthquake, which in this case has not enjoyed

the comparative harmlessness of submarine disturbances as it lies across the main series of trans-Atlantic cables.

The re sounding of the ocean around the epicentral area of the Cabot Channel earthquake may be expected to reveal instructive changes in depth

J. W. GREGORY.

4 Park Quadrant, Glasgow, C 3

### Method of Determining the Position of the Symmetry Axis of a Crystal by means of X-Rays.

A NARROW beam of X-rays, passing through the same point of a thin plate of a crystal, and moving in such a way that it successively occupies all the possible positions within a definite solid angle, will have Bragg's reflections from the atomic planes in the crystal. Their traces on a photographic plate, which is fixed relatively to the crystal, will give a sequence of lines the form and position of which will depend on the position of the reflecting planes and also on the constants of the crystal lattice

If the axis of symmetry of the crystal lies within the space angle described by the ray, and if it makes a small angle with the perpendicular to the photographic plate, then on the latter will appear a series of hyperbolæ, symmetrically situated, as may be seen on the photograph (Fig. 1) If the orientation

FIG 1.—Quartz.

of the crystal in relation to the photographic plate is known, the position of the axis in the crystal may be found, and some data may be obtained regarding its structure.

The above-mentioned scheme was realised in the following manner: a system consisting of a rigidly connected photographic plate and a small crystal, placed at a distance of 17 mm in front of the plate, slowly rotated round the horizontal line passing through the crystal and perpendicular to the plate, and oscillated round a vertical axis which also passed through the crystal intersecting the first one. A horizontal beam of rays emitted by the target of a Rontgen tube passes through a pin-hole placed close before the crystal, through the point of intersection of both axes of rotation, and then is stopped by a small fixed screen situated in front of the photographic plate. This screen prevents the blackening of the plate by the undeflected beam and thus only reflected rays strike the plate and give the above-mentioned picture. The diagrams thus obtained are equivalent to the '*P*-patterns' with an electron beam described by Kikuchi (*Japanese Journal of Physics*, vol. 5, No. 2).

It is obvious that the same picture will be obtained by means of a wide cone of rays emitted from a large radiating surface and passing through the above-mentioned pin-hole. In this case it is not necessary to rotate the plate and the crystal, but the blackening of the plate, caused by undeflected rays, spoils the photographs.

W. LINNIK.

Optical Institute, Leningrad, Oct. 9.

### Weitere Beobachtungen uber die Dissymmetrie der Emission von Serienlinien.

AN einer fruheren Stelle dieser Zeitschrift (NATURE, Juli 27, 1929, p. 125) habe ich eine kurze vorlaufige Mitteilung uber die neue Erscheinung der Dissymmetrie der Lichtemission im elektrischen Feld veroffentlicht. Im Folgenden seien kurz die Ergebnisse weiterer Beobachtungen uber diese Erscheinung mitgeteilt.

Wie ich in meiner Schrift uber die Axialitat der Lichtemission und Atomstruktur (Polytechnische Buchhandlung A Seydel, Berlin, 1927) dargelegt habe, stellen die im elektrischen Feld erscheinenden Komponenten der Linien des Wasserstoffatoms Linienserien von bestimmter Charakteristik dar Von diesen Wasserstoffserien habe ich auf ihr Verhalten in der neuen Erscheinung folgende Linien untersucht von der Serie $2s - mp^2$ die Linien $3p^2H_\alpha \pm 1$, $4p^2H_\beta \pm 6$, $5p^2H_\gamma \pm 13$, von der Serie $2p^2 - md^3,f^3$ die Linien $4d^3,f^3H_\beta \pm 4$, $5d^3,f^3H_\gamma \pm 10$, von der Serie $2s - mp^4$ die Linien $4p^4H_\beta \mp 2$, $5p^4H_\gamma \pm 3$; von der Serie $2p^2 - md^5,f^5$ die Linie $6d^5,f^5H_\delta \pm 6$, von der Serie $2s - mp^6$ die Linie $6p^6H_\delta \mp 2$. Von allen diesen Linien werden diejenigen, welche vom elektrischen Feld nach Rot verschoben werden, langs der Achse des Feldes entgegengesetzt zur Feldrichtung intensiver emittiert als in der Feldrichtung Umgekehrt werden diejenigen Linien, welche vom elektrischen Feld nach Violett verschoben werden, langs der Feldachse in der Feldrichtung intensiver emittiert als entgegengesetzt dazu

Aus dem Spektrum des Heliums habe ich folgende Linien auf ihr Verhalten in der neuen Erscheinung untersucht und zwar in der Achse des elektrischen Feldes wie auch in einer 45° dazu geneigten Achse. fur Orthohelium von der Serie $2s - mp^2$ die Linie $3p^2$ λ3889, von der Serie $2p^2 - ms$ die Linien $4s$ λ4713 und $5s$ λ4121, von der Serie $2p^2 - md^3,f^3$ die Linie $3d^3,f^3$ λ5876, von der Serie $2p^2 - md^3$ die Linie $4d^3$ λ4472, von der Serie $2p^2 - mf^3$ die Linie $4f^3$ λ4469, von der Serie $2p^2 - mf^5$ die Linie $5f^5$ λ4025, von der Serie $2p^2 - mp^2$ die Linie $4p^2$ λ4519; fur Parahelium von der Serie $2S - mP^2$ die Linien $3P^2$ λ5016 und $4F^2$ λ3965, von der Serie $2P^2 - mD^3,F^3$ die Linie $3D^3,F^3$ λ6678, von der Serie $2P^2 - mD^3$ die Linie $4D^3$ λ4922. Alle diese Heliumlinien folgen in der neuen Erscheinung derselben Gesetzmassigkeit wie die Wasserstofflinien; es werden namlich diejenigen Linien, welche vom elektrischen Feld nach Rot verschoben werden, entgegengesetzt zur Feldrichtung intensiver emittiert, dagegen werden diejenigen Linien, welche vom Feld nach Violett verschoben werden, in der Richtung des Feldes intensiver emittiert.

Die ausfuhrliche Mitteilung über die vorstehenden Beobachtungen wird voraussichtlich in den *Annalen der Physik* erscheinen. Im Anschluss an sie werde ich die wichtigen theoretischen Folgerungen darlegen, die sich aus ihnen ziehen lassen.

J. STARK.

Grosshesselohe-Munchen, Nov. 18.

### Chemical Biogenesis and the Development of Secretion Cells.

AMONG the Research Items in NATURE of Sept. 14, 1929, p. 426, is a note upon an interesting paper recently published by Prof. John Read on "Some Biogenetic Relationships in the Menthone Series".

At the end of the paper referred to in the note (*Chemistry and Industry*, vol. 48, No. 32, p. 786; 1929) Prof. Read says: "The excessively delicate control of molecular transformation which is here implied appears to be a prerogative of the living organism. The organic chemist is powerless to effect such subtle differentiations by artificial means. At the present stage of our knowledge the finer mani-

testations of organic synthesis appear to be inseparably associated with the life-processes."

These statements, which are perfectly true, lead us immediately to postulate that the study of such problems as the origin of terpenes should only be done in close connexion with cytology and cell development. I have made two attempts to study the problem from this side and my results may interest some readers of NATURE.

Studies on the development of secretion cells (Diss., Geneva, 1927) led me to the conclusion that the ideas of Tschirch on this subject are erroneous. Tschirch held that the oil (terpenes) originated from the cell wall by a kind of gelatinisation of the latter; but my experiments on *Asarum europæum*, *Laurus nobilis*, and *Cinnamomum camphora* indicate that the oil (terpenes) is generated directly in the protoplasm. Thus an important chemical conclusion follows from a purely cytological investigation.

Moreover, in a subsequent study of *Persea indica* I have been able to determine the real mechanism of the oil-production (*Planta, Archiv f. wiss. Botanik*, 6 Bd., Heft 2, p. 216; 1928). The oil cells in their youngest stage, when still entirely filled with protoplasm, produce a small drop of a phosphatide-like substance, which is fixed to the cell wall. This 'initial drop', as I call it, serves later on as a membrane to the oil drop. The terpenes originate entirely from the protoplasm without demanding any such intermediate condition as the gelatinisation supposed by Tschirch. At the end of the process the cell is entirely filled with the oil drop, the protoplasm having completely disappeared. The oil drops can easily be detected inside the protoplasm on the spot where they have been formed. The droplets of oil produced thus by destruction of protoplasm are injected into the initial drop. This penetration is only rendered possible by the solubility of the terpenes in the phosphatides. The initial drop then extends, and filling up with terpenes it advances towards other drops in the cell, which are finally all incorporated in the large one. It is also probable that fresh quantities of phosphatides are added to the membrane of the drop as it increases in circumference within the protoplasm. I consider these phosphatides as the active ferments in the destruction of protoplasm (by necrosis or autolysis) and in the synthesis of terpenes. Their presence in the cell walls makes the adhesion of the initial drop easier and even calls for such a formation.

In connexion with these investigations I have formulated the following hypothesis dealing with the synthesis of terpenes in secretion cells.

The protoplasm as a whole is transformed into terpenes (together with phosphatides and perhaps some minor constituents). Thus a destruction of protoplasm has to precede the synthesis of terpenes, and this disintegration certainly leads through the stage of amino-acids. The deamination of amino-acids by the deaminases is a well-known process, which generally leads to the production of an alcohol. If the deamination be incomplete it will result in an aldehyde. *l*-Leucine, one of the most abundant amino-acids, would in these circumstances yield *iso*valeraldehyde.

This is the point at which my views meet those of Euler and of Kremers. But in my opinion, to derive either *iso*valeraldehyde (Kremers) or methylcrotonaldehyde (Euler) from acetone and acetaldehyde is open to question. These two substances could only derive from the fermentation of sugar, and the amount of sugar in these cells is minute. The aldolisation of aldehydes is a chemical process which must be as easy *in vivo* as it is *in vitro*. The aldolisation of two molecules of *iso*valeraldehyde leads immediately to a terpene with an open chain, and a subsequent internal aldolisation would result in cyclisation.

It will thus be seen that the common origin which Prof. Read recognises for these substances is protoplasmic in nature. It would not be in the least astonishing to find that most of our terpenes are derived from leucine through the intermediate stage of *iso*valeraldehyde. It only one of the many terpenes were produced by this method, the others could derive from it by aldolisation, methylation, hydration, oxidation, and other recognised natural processes.

Our present knowledge of the problem indicates the desirability of further investigation, and the results of Prof. Read's chemical work will be awaited with interest. I shall myself continue the work on the biological side.

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(Plant Pathologist to the Botanical Survey of South Africa)
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**Variations of Intensity Distribution of the Auroral Spectrum and the Possible Influence of Sunlight.**

IN a letter which appeared in NATURE of Aug. 17, 1929, p. 263, Prof. C. Størmer described some spectrograms, which he, together with Mr. Moxnes, had taken from sunlit auroræ and auroræ in the earth's shadow. From the spectrograms, Størmer draws the conclusion that the intensity of the auroral line relative to that of the negative bands for sunlit auroræ is much smaller than that found for aurora in the earth's shadow.

I do not think that from Størmer's experimental material we can draw any conclusion as to the possible

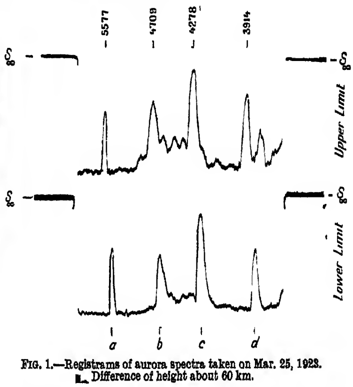


FIG. 1.—Registrams of aurora spectra taken on Mar. 25, 1928. Difference of height about 60 km.

influence of sunlight on the intensity distribution of the auroral spectrum. First of all, the two spectra given by Størmer do not fulfil the conditions which make them comparable, and are necessary for photographic evaluation of changes of intensity distribution, because the two spectra are taken on different plates; but the most serious defect of the material is that one of the spectra is very strongly exposed, while the other auroral spectrum is very weak.

Even in the spectrum corresponding to the earth's shadow the green auroral line has a smaller photographic density than the three principal nitrogen lines. In the spectrum of sunlit auroræ, the weakest of the nitrogen lines, 4709, is just visible on the plate, and then on account of the threshold effect we should expect the auroral line to be extremely faint even if no change of intensity distribution takes place.

Secondly, even if the spectrograms might show an effect qualitatively in the direction indicated by Størmer, we should not be able to take this as an

argument for the effect of the sunlight, for in his experiments an eventual sunlight effect would be mixed with a very considerable variation of intensity distribution, discovered by me in 1923 (*Phil Mag.*, **46**, p. 577, 1923), which was measured accurately under the most favourable photographic conditions (see article on auroræ, "Handbuch der Physik", Bd. 25, p 385). It was then found that the intensity of the auroral line relatively to that of the auroral nitrogen lines (4709, 4278, 3914) diminished considerably with increase of height. The effect is clearly shown in Fig. 1, giving registerings of two spectrograms on the same plate corresponding to a difference of altitude of about 60 km. For the lower limit, the auroral line 5577 gives a greater density than 4709, while at the upper limit the densities are inversed. Quantitative measurements gave the result that $\frac{(a/b)\text{ upper}}{(a/b)\text{ lower}} = 0\,695$ on a pair of spectra from one plate, and 0 76 on a pair from a second plate; $a$ and $b$ are the intensity of the auroral line and that of one of the nitrogen lines respectively.

Now Størmer's spectra correspond to differences of altitude of 200 km -300 km., and from the variation with altitude alone we should, in the case considered by Størmer, expect to find $\frac{(a/b)\text{ sunlit}}{(a/b)\text{ shadow}} = \text{about } 0\,3$, which would mean a very great intensity variation. Thus, even if it had been possible from Størmer's material to conclude that the sunlit aurora gave a relatively weaker auroral line, this effect might be due merely to the altitude effect I discovered in 1923.

L. VEGARD

Oslo, Nov 15.

### A Haploid *Œnothera*.

A SINGLE haploid *Œnothera* occurred this year in a culture of $F_1$ hybrids which were non-viable, and this result is of such interest as to deserve a separate record

In 1927 reciprocal crosses were made between *Œnothera rubricalyx* and *Œ. eriensis*, both of which have fourteen chromosomes. *Œ. eriensis* × *rubricalyx* gave a uniform $F_1$ with the red pigmentation of *rubricalyx* and the small flowers of *eriensis* They bred true in $F_2$ and were strongly patroclinous except in flower size.

The reciprocal cross, *rubricalyx* × *eriensis*, made at the same time, produced a potful of seedlings which were yellowish in colour, developed a little chlorophyll, and then promptly died when their stored nourishment was used up. The striking non-viability of this hybrid type led to a repetition of these crosses in 1928 with the same results The *rubricalyx* × *eriensis* gave from one capsule 21 small and feeble seedlings, all of which died off simultaneously, showing a lethal effect. From another capsule, obtained by crossing different individuals of the same two species, 85 seedlings were obtained. They behaved in the same way as the preceding, except that two of the seedlings managed to survive for a time and one lived long enough to be planted out. It reached maturity and belonged to a new type, very much dwarfed and completely sterile as regards pollen and seed production

It was predicted that this plant might be a haploid, and such has proved to be the case, as it has only seven chromosomes in its somatic cells. The plant showed the red pigmentation of *rubricalyx*. Its leaves were small, narrow, and rather pointed, and these were regarded at first as resemblances to *Œ. eriensis*; but it seems more probable that these are characters pertaining to haploid *rubricalyx*

As regards the origin of this haploid mutant, it appears to have developed parthenogenetically from a *rubricalyx* egg under the stimulus derived from the foreign pollen tubes of *eriensis* The great bulk of the seedlings, which were non-viable, appear to have been true (diploid) hybrids with *eriensis*

The first haploid sporophyte in higher plants was discovered by Blakeslee in 1922 in the offspring of *Datura* plants which had been subjected to low temperature at about the time of fertilisation. Other cases of haploids have since been found in *Nicotiana*, *Triticum*, *Crepis*, *Solanum nigrum*, and recently in the tomato. They have usually resulted, like the above, from crosses between two distantly related species with a high degree of interspecific sterility. In the present instance, the sterility appears to be complete when the cross is made one way, while the reciprocal cross produces plenty of viable seedlings

A full account of this haploid mutant will be published later

R RUGGLES GATES.

King's College,
University of London, Dec. 2

### The Perfect Elasticity of Wool.

THE most striking property of the wool fibre is its ability always to return to its original length after stretching in cold water If, however, a fibre is steamed in the strained position, it shows no tendency to return to its original length in cold water. So far as I am aware, it has hitherto been found impossible to induce such fibres to return to their original length, although *partial* recovery occurs on re steaming in the absence of tension. During the course of another investigation, however, I have recently found that fibres which have taken a permanent set of the kind just described, recover the property of perfect elasticity in caustic soda solutions. For example, a fibre which had been stretched and steamed for 15 minutes at 47 4 per cent extension, returned to its original length in 14 minutes in 0 15 $N$ caustic soda solution. Contraction does not cease when the original length is attained, but continues beyond this point until a real shrinkage of about 10 per cent of the original length is observed. The rate of recovery increases with the strength of the solution, but is measurable even in 0 01 $N$ caustic soda. The discovery opens up a number of possibilities in regard to 'finishing' processes in the wool textile trade, but of even greater significance is the contribution which it makes to knowledge of the elastic phase in the wool fibre and the changes which it undergoes during stretching and steaming Complete details of the results and conclusions of the investigation will be described in another place.

J. B. SPEAKMAN.

The University, Leeds, Nov 28.

### Continents and Oceans.

As the result of my letter on "Continents and Oceans", which appeared in NATURE for Nov. 30, several correspondents have directed my attention to Lothian Green's 'tetrahedral hypothesis' This hypothesis was devised to explain why the continents have oceans at their antipodes, and Prof. J. W. Gregory has given an excellent account of it in his little book entitled "The Making of the Earth", published in 1912.

I am sorry that I had not seen Prof. Gregory's book before I wrote my letter, as it would have helped me to emphasise the point which I wished to make; for the object of my letter was not to describe new relationships between the continents and oceans, but to direct attention to the necessity for taking the relationships which I described into account when discussing Wegener's hypothesis.

G. C. SIMPSON.

Meteorological Office,
Air Ministry, Kingsway, W.C.2, Dec. 5.

## The Proposed New 200-Inch Telescope.

IT is now common knowledge that plans for the construction of a 200-inch reflecting telescope are being worked out at Mount Wilson observatory This enterprise has been rendered possible by the generosity of the International Education Board, which in May 1928 authorised its executive committee to provide for the construction of an astrophysical observatory equipped with a 200-inch reflecting telescope and auxiliary instruments. The proposed new observatory is to be conducted in close co-operation with Mount Wilson and the increased light-collecting power of the 200-inch telescope should permit further studies of the size and structure of the galactic system, of the spectra of the brighter stars under very high dispersion, and of many other important problems. A short account of the plans for the 200-inch in so far as they have matured will interest many readers of NATURE More complete details are given by Prof Hale in an article in the November number of *Harper's Magazine*, the source from which the substance of the present article has been drawn.

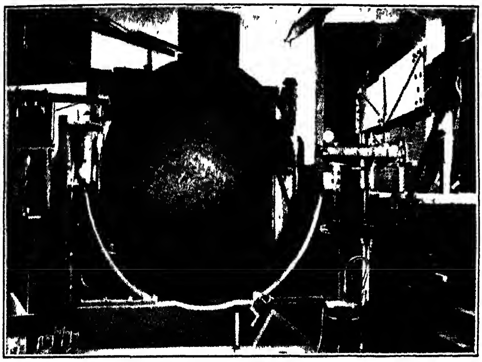

FIG 1 —The 101-in mirror in the vertical position for optical testing.

In the construction of the new instrument the experience gained in constructing the present 100-inch instrument at Mount Wilson will naturally be of great assistance, and it will be helpful to recall some of the difficulties met with in the construction of the smaller instrument. The greatest troubles were in the construction of the mirror itself It is obviously desirable to secure a disc of glass which is free from internal flaws, but in the case of the 100-inch the disc which was finally used was one which was delivered in 1908 and was rejected at the time. It was only after further attempts to produce a suitable disc had failed that the present mirror was figured from this rather unsatisfactory disc. The disc in question was full of bubbles, as can be seen from Fig. 1, which is reproduced from a recent memoir by G. W. Ritchey.[1]

[1] "The Development of Astro-Photography and the great Telescopes of the Future." Publié sous les Auspices de la Société Astronomique de France. 1929.

The chief difficulty in the construction of very large discs of glass arises from the fact that they suffer devitrification during the weeks or months required for the slow cooling known as annealing This leads to loss of rigidity—a serious defect. Furthermore, glass is a poor conductor of heat and consequently the outer parts of a large silver-on-glass mirror change in temperature more rapidly than the inner The curvature of the surface is thus affected, and this means that the stellar image, instead of being nearly a point, may often be expanded into a much less brilliant disc This defect can in the case of existing mirrors be partially removed by the provision of constant temperature water jackets and a similar plan might conceivably be adopted in the case of the 200-inch, but the difficulties clearly increase with size. It seems probable that a limit has already been reached in the construction of large mirrors of solid glass.

Prof G W. Ritchey has recently advocated the construction of cellular mirrors, constructed by

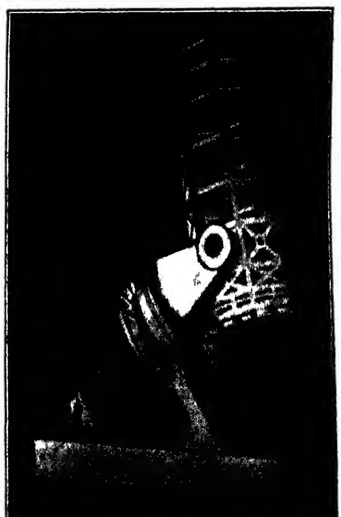

FIG. 2.—Tentative model of 200-inch telescope for the California Institute of Technology. Made by the Warner and Swasey Company after preliminary designs by E. P. Burrell and Francis G. Pease.

building up a kind of honeycomb from thin glass plates, and this plan has been considered as

Wilson by Prof Hale and his collaborators. Its adoption, however, has not been favoured, on account of the difficulty of figuring with optical perfection the thin glass faces and the edges of the honeycomb structure In addition, doubts have been entertained as to the optical permanence of a heavy cemented structure subjected to wide ranges of temperature

The plan which at the present moment appears most promising to the astronomers concerned is to make the mirror of fused quartz, a substance which possesses a very small temperature coefficient. The process consists of fusing a mass of nearly pure silica in a circular electric furnace which constitutes the mould. The disc thus obtained contains a large number of small bubbles, but it can be ground to the approximate curvature of the mirror desired and then coated to a sufficient thickness with perfectly transparent quartz free from bubbles The final figuring is then carried out on the surface of this clear layer. The quartz composing the clear layer is sprayed on to the hot disc by means of multiple oxy-hydrogen burners. A 22-inch disc has already been constructed in this way, and it is now proposed to make a 60-inch mirror before finally embarking on the construction of the 200-inch mirror itself

With regard to the figure of the mirror, it has been decided to construct it with a focal length of 55 feet, that is, with a focal ratio of $f$ 3·3 The use of such a small focal ratio will give an immense concentration of light, but in common with all short focus mirrors the field of good definition will be small. It is proposed to remedy this defect by the use of a correcting lens, designed by Dr F. E Ross, which will be placed immediately in front of the photographic plate at the principal focus of the 200-inch mirror Dr Ross has in addition to this computed a correcting lens which will, it is hoped, reduce the equivalent focal ratio to $f$ 2 2. Provision will also be made for a Cassegrain arrangement with an equivalent focal ratio of $f$ 10 The convex mirror in this arrangement will be 60 inches in diameter.

The telescope will be mounted equatorially The problem of the mounting will be an engineering enterprise of no mean dimension, and the lessons learnt and the difficulties met with and overcome in the mounting of the existing 100-inch telescope will doubtless be invaluable in this connexion

Considerable attention is being paid to the selection of a suitable site It is highly important that the efficiency of the 200-inch should not be impaired by poor seeing arising from atmospheric tremors. The experience gained with the 100-inch has shown that at Mount Wilson itself a 200-inch telescope could be depended upon to show a gain in keeping with its increased size It is, however, probable that a still better site can be found in California, and the possibilities are being explored by observations at various sites with portable telescopes

One of the proposed models for the 200-inch telescope, which is now on exhibition in the building of the National Academy of Sciences, Washington, D C, is shown in Fig 2 It should be mentioned that the plans include the provision of an adequate laboratory and workshop W. M. H G.

## The Locust Problem.

By Dr. A. D. IMMS, F.R S

THE theory of the phases of locusts, advanced by B. P. Uvarov in 1921, is now well known to entomologists and has proved a fertile stimulus to further investigation of this important problem. It recognised the existence among these insects of two definite or extreme forms—one gregarious and the other solitary—which are connected by a continuous series of less defined transitional forms Messrs. B. P. Uvarov and B. N. Zolotarevsky[1] have recently discussed certain aspects of the problem, in the light of new observations made by S. A. Predtechensky in Russia, and by the junior author in Madagascar. Although their remarks apply more especially to the well-known species *Locusta migratoria*, these authors believe that a standard phase nomenclature, applicable to all species, would be both possible and advantageous. According to their interpretation a locust can exist in three unstable biological phases, namely, a solitary one, *phasis solitaria*: a gregarious one, *phasis gregaria*, and a transitional phase between these two which they term *phasis transiens*. These phases differ from each other in morphological and colour characteristics, on one hand, and in biological features (mainly behaviour) on the other. Whether it will prove possible to distinguish such phases solely by the convenient method of examining their morphological characters, can only be determined by studying the whole series of phases of a given locust in a specific locality.

The solitary phase consists of isolated individuals and is represented where no swarms exist, or have existed, within at least one preceding generation. The transient phase is not represented by any definite form, but by a continuous series of transitional forms between the solitary and gregarious phases. Such a series may be observed either (*a*) when the transformation is from the solitary phase towards the gregarious phase, when it may be termed *phasis congregans*; or (*b*) the tendency is in the opposite direction, when it is termed *phasis dissocians* These two phases are, therefore, essentially of a biological nature, but it appears that it may be possible to distinguish them also by minor details of structure and colour. The gregarious phase is that assumed when individuals form dense and extensive emigrating swarms (Fig. 1). Recent studies of *Locusta migratoria* have shown that, although this species is a very

[1] Phases of Locusts and their Interrelations. *Bull. Entomological Research*, 20, pp. 261-265, Oct 1929.

definite unit, it exists as three subspecies, namely, *rossica* in Central Europe and possibly Western Europe, *migratoria (sensu str)* in south-east Russia and *migratorioides* in the tropics and subtropics Each of these subspecies may pass through the three phases already mentioned, but it is possible that all may not prove to be equally polymorphic The application of this theory to other species indicates that, in the past, the solitary and gregarious phases being in most cases so distinct they have hitherto not been recognised as such Great confusion has naturally resulted, since they have been regarded as distinct species under separate names From the practical point of view of locust control it is, obviously, of prime importance to study the behaviour of these insects in the light of Uvarov's theory. The theory lends a new interpretation of the causes of locust outbreaks, and by directing research along a defined course it will co-ordinate investigation, hitherto largely prosecuted blindly in the hope of eventually alighting upon some solution of the problems concerned. It opens up the possibility that transformation of locusts into the gregarious phase may sometimes be circumvented, and the location of the breeding grounds of the latter phase may lead to the destruction of immense numbers of potentially harmful individuals. This aspect of the subject is fully discussed in Uvarov's recent treatise[2] on locusts, which has already been noticed in these columns

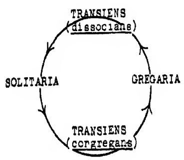

FIG 1.

On April 29 of this year the chairman of the Committee of Civil Research[3] appointed a scientific sub-committee of ten members under the chairmanship of Sir Henry Miers, with the following terms of references:

"To consider and report on:

(*a*) Means for the mass destruction of the Desert Locust *Schistocerca gregaria* Forsk.

(*b*) Methods for ascertaining the reasons for the periodic swarming of this species with a view to its control"

The depredations of the Desert Locust are of immediate concern to the Empire, since an enormous area of British Africa is periodically affected besides Palestine, Transjordania, and Iraq. In Kenya, for example, it is mentioned that £50,000 has already been spent on control and relief measures with respect to an outbreak of this insect which is still continuing at the present time. The Kenya government has now taken power to prohibit all exports of foodstuffs from the territory, and the Legislative Council has passed a resolution authorising expenditure up to £200,000 to the Food Control Board to enable it to discharge its function.

As a preliminary step the Committee of Civil Research has issued two reports of the Locust Sub-Committee which were presented to Parliament in July 1929 In the first report it was recommended that the collection of information from all available sources respecting the habits and behaviour of the Desert Locust should be proceeded with forthwith. This information should be collated and distributed to the territories affected by the insect in question. In order to effect this scheme, it was recommended that financial arrangements should be made to enable the Imperial Bureau of Entomology to commence this work In its second report the Sub-Committee drew up a draft scheme of the research it deemed necessary to be carried out, and stress was laid upon the possibility of employing aeroplanes for purposes of reconnaissance and perhaps also for the destruction of locusts It recommended that colonial governments, interested in this specific locust problem, should be communicated with and invited to indicate whether they would assist by contributing to the cost and by providing local facilities if a proportional Imperial contribution could be arranged. It also suggested that communication, in a similar sense, should be made for the purpose of obtaining the views of the Government of India With the object of obtaining the fullest information possible respecting the Desert Locust, it is further suggested that inquiries should also extend to foreign territories affected by the insect in question

About the middle of the present year evidence of the enormous destruction occasioned by the Desert Locust in Palestine had come to hand in the form of an article by Mr. G. E. Bodkin,[4] Government Entomologist The history of locust invasions in Palestine indicates that these visitations have occurred in recent years with remarkable regularity. Thus 1865, 1878, 1890, 1902, 1915, 1928 are marked by visitations of this insect—an unvarying period of 12-13 years elapsing between the events The year 1915 was a most disastrous one, and in the Jaffa district alone damage to the extent of about £200,000 is stated by Mr. Bodkin to have resulted from locust depredations. Since the destruction was practically universal in Palestine the damage in the whole country reached a colossal figure. The suffering endured by the population, as it happened, was alleviated to a marked degree by the War, which involved the occupation of Palestine by the British army. The large supplies of food thus brought in, and the liberal payment for services rendered, helped the population at a time when it was demoralised by the destruction of a means of livelihood.

Palestine was visited by another invasion in 1928, and the chief facts respecting this event are recounted in Mr. Bodkin's article. It appears that there were three successive waves of invasion, but, by comparison with the event of 1915, they were but light. Ability to anticipate such an occurrence resulted in very little serious damage being incurred. The appearance of the Desert Locust in Hauran and in Egypt the previous year gave timely

[2] "Locusts and Grasshoppers" London, 1928

[3] Committee of Civil Research Locust Sub-Committee First and Second Interim Reports. London. H.M Stationery Office, 1929. Price 3*d* net.

[4] "The Locust Invasion of Palestine during 1928." *Bull. Entomological Research*, 20, pp. 123-139, Aug 1929, with 3 text figs. and 3 plates.

warning, and preparations for a control campaign the following year were soon embarked upon. Consequently, 1928 was the first time that locust invasions in Palestine were combated with an adequate organisation of material, equipment, and personnel The campaign was assisted by the drought, which rendered the ground unsuitable, for the most part, for the insects to lay many of their eggs.

The nature of the control measures that were applied can only be briefly mentioned here. The destruction of the winged locusts, prior to egg-laying, means the elimination of hordes of potential young locusts, and Mr. Bodkin describes a type of flame-thrower devised for this purpose. These machines did good service at night owing to the habit of the Desert Locust of clustering in dense masses at that time The arming of large numbers of villagers with hand nets resulted in further destruction, and they also assisted by encircling swarms of gravid locusts, and slowly driving them to a common centre, to be exterminated by use of flame-throwers. The methods prosecuted were so efficient that most of the egg-laying became restricted to the Jericho district. The resulting young locusts or 'hoppers' were destroyed by spraying with kerosene emulsion, and later by fire and by means of arsenicals. Mr. Bodkin's instructive and timely report should do much to encourage those who have to encounter the same menace in other lands It is evident that adequate preparation, and the application of the right measures coupled with a knowledge of specific locust behaviour, were collectively responsible for the good results achieved.

The Palestine outbreak is directly related to a much more formidable and simultaneous invasion by the Desert Locust of the southern Sudan, Kenya, and Tanganyika Territory The duration of this menace cannot be foretold with certainty, but it appears probable that it will continue until 1931 The reports of the Committee of Civil Research synchronise, therefore, with a recurrent outbreak of first magnitude. This fact should serve to stress the urgency of carrying out the procedure advocated with as little delay as possible. A judicious expenditure of £20,000 or £30,000 in the course of four or five years should reap benefits out of all proportion to the money so devoted The greatest need is for exact information on the behaviour and habits of the Desert Locust, and the co-ordination of such information from as many sources as possible. Without this knowledge, we shall be merely groping in the dark for many years to come simply because there is no adequate foundation to work upon.

## Irradiation and Health.

THAT exposure to sunlight or some source of ultra-violet, luminous, or heat rays has a beneficial effect upon general health has been claimed by many competent observers That insolation is of great value in the treatment of various forms of tuberculosis may be taken as well established, although the cooling power of the open air, as well as the sun's rays, plays a part in the favourable effects produced. Again, that vitamin D is formed from ergosterol in the skin when the latter is exposed to ultra-violet light has been definitely shown, as well as the development of an increased bactericidal power in the blood, after suitable irradiation of the same organ. But whether such effects are accompanied by an increase in the resistance of the body to infection has not been satisfactorily demonstrated, in spite of a very general impression that suitable exposure to a source of light does improve the general health. Colebrook[1] has therefore submitted this question to an experimental study, and at the same time has investigated the influence of light upon the rate of healing of a purely local infection

In the first investigation the influence of light upon the health and development of school children was studied: their ages ranged from five to seven years, and the period of observation extended from August 1927 to March 1928. They were divided into three groups, upwards of a hundred children in each: one acted as a control, the others were exposed, clad in bathing slips only, three times weekly to a direct current long-flame carbon arc lamp, in one of these the light from the lamp was screened by glass, so that only rays longer than about 3342 A. reached the children The dosage aimed at was one which would just fail to give an erythema reaction on the skin of a child of average sensibility. it was gradually increased by diminishing the distance of the child from the lamp, by increasing the time of exposure, and also the output of the lamp. Pigmentation of the skin was produced in a number of the children by the treatment. The groups were selected to be as similar as possible as regards ages and types, and it was considered that the home conditions were, on the average, also similar in the groups and were such that any benefit due to the irradiation would be easily seen and not counteracted by a poor home environment.

The progress of the children was followed by recording height and weight at intervals, by frequent observations of the occurrence of chilblains and colds, or other infections, and by noting the subjective impressions of the medical officer, teacher, and parent. The results were, in brief, that exposure to light had almost no beneficial effects whatever: in fact, the advantage was usually to the control group as compared with the lamp groups, or to the screened lamp group as compared with the unscreened However, as regards progress in schoolwork, exposure to light, especially the screened lamp, appeared to be of favourable influence, whilst the unscreened, and

[1] Medical Research Council. Special Report Series, No 131 Irradiation and Health. A: Ultra-Violet Irradiation of School Children, B: Irradiation of Varicose Ulcers. By Dora Colebrook. Pp. 47. (London: H.M. Stationery Office, 1929.) 1s. 6d. net.

to a certain extent the screened lamp seemed to exert at first a stimulating effect on increase in weight, although this stimulus was only temporary in its action, and the period of increased growth was followed by one of relatively decreased growth rate, so that at the end of the experiment the advantage was with the control group As regards infections, the evidence was definitely against the exposure to light having any favourable effect, but, for what they are worth, the subjective impressions of teachers and parents were in favour of the lamp groups

It thus appears that, except for a possible temporary stimulating effect upon growth, exposure to light is without influence upon bodily states which are susceptible of objective measurement, but may be taken to improve, although only slightly, that state which can only be described as the general health and well-being It may be emphasised that these conclusions only apply to the conditions of this particular experiment, and that other sources of light, etc, might have different effects, that the home conditions of the children were uncontrolled (though probably sufficiently similar in all the groups), and finally, that the control group differed from the others not only in not being exposed to light, but also in not sharing the necessary routine incidental to this exposure, such as withdrawal from lessons, dressing and undressing, and exposure to the different temperature of the lamp room as compared with the class room

In the second study, Colebrook investigated the influence of ultra-violet light from mercury vapour lamps upon the healing of varicose ulcers: either the leg up to the knee or the ulcer itself only were irradiated, between treatments only a simple dressing and bandage were applied For controls, a series of cases was treated with Unna's zinc oxide and glycerine paste The result of the investigation was that the cases treated with light of very varying intensities responded much less satisfactorily than those dressed with the paste the difference was most marked in the case of the ambulant patients, indicating that any benefit seen under light treatment in patients kept in bed was probably largely due to the accompanying rest and not to the light No difference was observed in the course of healing between irradiated and unirradiated areas of the same ulcer, other conditions being the same for both and finally, relief of symptoms was not obtained during light treatment but was a marked feature in the patients treated with Unna's paste.

## Obituary.

### DR HAROLD WAGER, F R S.

DR HAROLD WAGER, whose death occurred on Nov 17, had shown his interest in science at an early stage in his career In 1885 he was associated with Mr Auberon Herbert as private secretary, an association which led to their collaboration in the production of a paper in the *Contemporary Review* upon "Bad Air and Bad Health", which afterwards appeared (1894) as a pamphlet From 1886 onwards Wager went to the Royal College of Science, where he was a regular attendant at Dr D H. Scott's classes upon botany, and is still remembered by the latter as one of his most brilliant students.

In 1888, Wager was appointed demonstrator in biology in the Yorkshire College at Leeds Since that date, although he has not always resided at Leeds, he has been so much identified with both science in Yorkshire and with the Yorkshire College —and afterwards the University of Leeds—that he is generally recognised as one of the most distinguished of a very remarkable band of scientific naturalists of the county of the broad acres In 1894 he married Winifred Miall, the only daughter of Prof. L. C. Miall, the first and only professor of biology in the Yorkshire College.

On the outbreak of the War, with the consent of the Board of Education, Dr. Wager voluntarily undertook the direction of the Department of Botany during the absence of Prof J. H. Priestley upon war service. After the armistice he remained for some time in contact with the Department, in which he held an honorary lectureship, and it was with regret that the University Council recently received his resignation of that post when he found himself unable to keep in touch with the activities of the Department

Through his early association with Dr D. H Scott, some of Wager's earliest scientific papers were upon plant anatomy, including a paper, in collaboration with Dr. Scott, upon the floating roots of *Sesbania aculeata*, but throughout his career Wager showed a catholic diversity of interest—every subject open to experiment and observation in the scientific spirit being of appeal to a man with the temperament of the naturalist and observer, and the training and technique of the student of science He first established his scientific reputation by a long series of papers upon the cytology and life-history of the fungi, which were published during the years 1889–1900. Early in the new century he was also making observations upon the cytology of the blue-green algæ, the Cyanophyceæ; but what distinguished Wager as a student of such problems was that he never lost interest in the growing plants in the field As a result his specialist studies of these two groups have the very unusual accompaniment that he has published in the *Naturalist* keys to the determination of species of Oscillatoria and Phormidium, and also a very useful guide to the determination of genera of the Agaricaceæ.

This interest and sympathy with the field of work of the naturalist, coupled with his specialist knowledge of technique in fields usually outside the naturalist's province, made Wager a great influence in deepening and extending the contribution of Yorkshire naturalists to biology. Under his

chairmanship the annual mycological forays of the Yorkshire Naturalists' Union have done very successful work in promoting interest in these plants, and in adding to our knowledge of the Yorkshire species In 1913, as president of the Union, he devoted his address to a brief résumé of his observations upon the movements of free-swimming micro-organisms, a fascinating subject which showed him at his best, alike as a naturalist and as a brilliant manipulator of microscopic living organisms, alive to the fact that the infinitely small amongst living creatures still have to obey physical laws

On the occasion of the meeting of the Yorkshire Naturalists' Union in Leeds in 1914, the University conferred upon him the honorary degree of D.Sc in recognition of his great contribution to science and his distinguished association with the study of natural science in Yorkshire. In 1904 he had been elected a fellow of the Royal Society.

Dr Wager's severance from academic laboratories, upon his appointment as one of H M. Inspectors of Secondary Schools, in no way diminished his scientific activity. With simple laboratory appliances, but with an almost uncanny *flair* for microscopic manipulation, he continued to carry out observations in various fields of biology, and in particular turned his attention to a number of problems of plant physiology His photographs through the lenses of the leaf epidermis were as beautiful a demonstration of the capacity these cell wall structures showed to focus objects, as his experiments were to show that Haberlandt's views as to the function of the 'ocelli' needed revision He also made numerous observations upon the leaf pigments and other plant pigments, many of which, probably, have never been fully embodied in his published writings

These unremitting scientific labours were a daily accompaniment to Wager's conscientious fulfilment of his duties as an inspector of schools The result was, naturally, that the teacher of biology in the school, apt to have recourse to the easier path of instruction through text-book and diagram, was constantly being reminded of the wide gap that may exist between the formal description and the object awaiting the unprejudiced regard of the observer. Just as the amateur naturalist, seeing in Wager a kindred spirit, was led by his example to take more pains and extend the range of his scientific technique, so the professional teacher was encouraged to leave routine repetition of second-hand facts, to observe for himself, to become, in fact, a naturalist, and thus to develop a new enthusiasm which rapidly communicated itself to his pupils

During Wager's long association with Yorkshire, he learnt to love the Yorkshire dales. It was in his cottage in Lyttondale that he died after a short illness, and he was laid to rest in the little churchyard at Arncliffe amongst associations that were always dear to his memory, and to those of his many Yorkshire friends. There they will like to think of him—at rest in surroundings that were always congenial to his spirit.

SIR SAINTHILL EARDLEY-WILMOT, K C I E

THE death of Sir Sainthill Eardley-Wilmot on Nov 13, at Henley-on-Thames, removes a great forester who spent forty-seven years of his life in the service of his country Eardley-Wilmot was the fourth son of Augustus Hillier Eardley-Wilmot, and was born on July 17, 1852 He joined the Indian Forest Service in December 1873, after having spent three years undergoing his forestry training in Germany. There can be little doubt that some aspects of this training had a considerable influence on Eardley-Wilmot's subsequent career for he was able to appreciate to the full the advantages, as also the weaknesses, of a purely German training, when strictly applied, to the very dissimilar and varying conditions of the sub-tropical and tropical forests Wilmot was appointed to the old North-West Provinces and Oudh, spending the first sixteen years of his service as an executive officer in charge of several forest divisions in the Provinces In 1890 he was promoted to administrative rank and passed the following eight years as Conservator in Oudh, where his organising ability, combined with his great professional knowledge, radically changed the management of the forests by introducing a more scientific conservancy and earned him the encomiums of the local government

It was during this period that, as a result of sylvicultural studies carried out in the forests, Eardley-Wilmot wrote a series of important papers entitled "Notes on the Regeneration of the Sál (*Shorea robusta*)"; "Notes on Sál Forests", "Notes on Improvement Fellings", "Sál Coppice Forests of Oudh", "Notes on the Treatment of Shisham (*Dalbergia Sissoo*) and Khair (*Acacia Catechu*) in the Sub-Himalayan Tracts"—all of which were published in the Appendix Series of the *Indian Forester* in the nineties of last century. They formed a very valuable addition to the scanty knowledge at the time existing on the sylvicultural characteristics of these species. From 1900 until 1902 Eardley-Wilmot was in Burma, and in February 1903 was appointed to officiate as Inspector-General of Forests, and afterwards confirmed.

Apart from numerous activities in administrative directions, notably the improvements he was able to get effected in the emoluments of officers of the Department of all grades, and the steps he took to improve the forest education of the executive and provincial staff of the Department in India, Eardley-Wilmot's greatest achievement was connected with the inauguration of the Imperial Forest Research Institute at Dehra Dun. At the time Eardley-Wilmot passed through Calcutta *en route* for Burma, the then Inspector-General of Forests, Mr B Ribbentrop, was endeavouring to obtain the consent of Government to the appointment of a forest officer to take up special research work in forest entomology. Eardley-Wilmot was keenly interested in this new departure. The appointment applied for was made for two years, and I myself took up the work. At the end of the period the question of continuing the work was undecided. I was in charge of the Indian Museum as officiating

superintendent, and Eardley-Wilmot came back to Calcutta from Burma. This was in February 1903 and the first of many conversations then took place between the Inspector-General of Forests and myself on the subject of the formation of a Forest Research Institute. Lord Curzon was Viceroy, and once Eardley-Wilmot had obtained his sympathetic consideration, the matter went through and the Institute was inaugurated in 1906, six research posts being filled by officers selected from the Forest Department. The Inspector General often said that his reply to the query as to where he was going to obtain his research officers, "From the Department, sir", pleased the Viceroy almost more than any other incident in connexion with the new departure. For Lord Curzon was the Viceroy who really commenced the introduction of the scientific expert into India, and it proved a difficult work at first to obtain suitable men. The research officers were appointed and commenced work. But there were no buildings and no equipment. All that had to come. The opening by the Viceroy of the greatly enlarged Forest Research Institute at Dehra Dun (NATURE of Nov. 16, p. 778), but six days before Eardley-Wilmot's death, is a witness to the enormous value of the step taken in 1906.

Eardley-Wilmot left India in 1908 on furlough, retiring from the service in 1909. His work was not finished. For he was appointed in 1910 as one of the Commissioners of the newly formed Development Commission, forestry being his special charge. With his Indian experience behind him, he determined that forestry education was one of the first lines to take up in Great Britain. Grants for this purpose were made to various institutions. Edinburgh received a grant from the Development Commissioners of £10,000. The larger part of this grant was made with the object of erecting suitable departmental buildings (we only had two cellars in the old University buildings at the time), the University Court adding a similar sum. A further grant was offered to enable a chair to be established, and this sum also eventually materialised. At the end of five years as a Development Commissioner, Eardley-Wilmot was appointed forestry adviser to the Commission and held the appointment for five years. At the end of this period the Forestry Commission came into being and took over charge of forestry work from the Development Commission. This ended Eardley-Wilmot's active life as a forest officer.

It is perhaps too soon to adjudicate correctly upon the value of Eardley-Wilmot's ten years' work for forestry in Great Britain and Ireland. The Development Commissioners had no executive powers, grants were given in the interests of afforestation and a commencement had been made with the introduction of a system of co-operation between landlord and State in the formation of new plantations on a profit-sharing basis. For the purpose of this review of Eardley-Wilmot's life's work, he will be remembered for the part he played in bringing the Forest Research Institute into being in India, and—what he himself would value as a still stronger claim—he will be remembered as a fine forester and magnificent sportsman. His "Forest Life and Sport in India" is regarded as a classic as much from the scientific forestry viewpoint as from a natural history and sporting one. He also published two other books, "The Life of a Tiger" and "The Life of an Elephant", both of which gave evidence of a close study of the lore of the jungle.

E. P. STEBBING.

### MR. W. R. BOWER

THE death occurred at his home at Huddersfield, on Nov. 20, of Mr. William Richard Bower, who was for more than thirty years head of the Physics and Electrical Engineering Department of the Huddersfield Technical College.

Mr. Bower was born at Southampton and received his early education at the Taunton School and the Hartley College in that town. Gaining a national scholarship, he proceeded to the Royal College of Science, London, of which he became an associate and later a member of staff. Before the commencement of his long period at Huddersfield in 1896, he served on the staffs of the University College of Wales, Aberystwyth, and Brighton Technical College. He was a fellow of both the Physical Society and the Institute of Physics, and, after his retirement, received the honorary title of emeritus professor of physics at Huddersfield Technical College. His breadth of knowledge, attention to detail, and great experience as an experimentalist gave a marked impress to his teaching and brought him the warm affection of his students.

Amongst Mr. Bower's early activities at Huddersfield was the practical application of X-rays, in which he was a local pioneer, many and varied were the cases then brought to the College for examination. Later, as a writer, he was joint author of Bower and Satterly's "Practical Physics" and author of "Primary Physical Science" which appeared last year. He was especially interested in optics and published papers illustrating the application of graphical and geometrical methods.

Mr. Bower's steadiness of aim, disinterested sincerity, and great capacity for administrative work led him to take active interest in the Association of Teachers in Technical Institutions. He served on the national executive of this body for many years, and, at a critical period in the history of the teaching profession, became president of the Association and a member of the Burnham Committee. His judicial temper and unfailing courtesy made him an invaluable negotiator.

WE regret to announce the following deaths:

Dr. Charles Chilton, lately professor of biology and Rector of Canterbury College, New Zealand, an authority on the crustacea of New Zealand and the Antarctic regions, on Oct. 25, aged sixty-nine.

Dr. F. W. Dootson, lecturer and demonstrator in chemistry in the University of Cambridge, on Dec. 12.

Admiral of the Fleet Sir Henry Bradwardine Jackson, G.C.B., K.C.V.O., F.R.S., a pioneer in the development of wireless telegraphy, on Dec. 14, aged seventy-four years.

## News and Views.

ON Dec. 23 occurs the centenary of the birth of the distinguished French chemist Paul Schutzenberger, who was born at Strasbourg in 1829. The son of a professor of law, Schutzenberger took the degree of M.D. at Strasbourg, was for a short time assistant to Persoz (1805–1868), the professor of chemistry in the Paris Conservatoire des Arts et Métiers, and for some years a professor at Mulhausen High School. Returning to Paris in 1865, he became assistant to Balard at the Collége de France, succeeded to Balard's chair in 1876, and from 1882 was also Director of the municipal École de Physique et de Chemie. In 1888 he was elected a member of the Academy of Sciences in the place of Debray, and he died at Mézy, Seine et Oise, on June 26, 1897. The following year his bust was placed in the Ecole de Physique. Schutzenberger paid particular attention to industrial chemistry, especially of colouring matters, and was known for his long researches on the constitution of alkaloids and of the albuminoid bodies. He also prepared a new series of platinum compounds. His works included his book on fermentations (1875) and a treatise on general chemistry in seven volumes. Towards the end of his life he adopted the view that the elements had been formed by some process of condensation from one primordial substance of extremely small atomic weight, and expressed the opinion that atomic weights within narrow limits are variable.

WE have received from the Department of Research in Terrestrial Magnetism of the Carnegie Institution of Washington the following statement relating to the loss of the non-magnetic research vessel *Carnegie*, referred to in our issue of Dec. 7, p. 883: "The survey yacht *Carnegie* and her scientific equipment were completely destroyed in the harbour at Apia, Western Samoa, on the afternoon of Nov. 29, 1929, following the explosion of gasoline while it was being stored on the vessel. Capt. James Percy Ault, in command, and one cabin boy were killed, the engineer and mechanic were seriously injured, and three of the sailors hurt. The scientific members of the staff, with the exception of W. C. Parkinson, second in command, are expected with Capt. Ault's body at San Francisco about Dec. 19. Mr. Parkinson is remaining at Apia temporarily, from which place he will proceed later to take charge of the Watheroo Magnetic Observatory in Western Australia. The *Carnegie* was the property of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington and had completed about 45,000 nautical miles of her seventh cruise at the time of the accident. Since launching in 1909 she had traversed in all oceans from 80° north to 61° south, a total of nearly 300,000 nautical miles. The data gathered form valuable contributions to the science of geophysics, including terrestrial magnetism and electricity, oceanography, and meteorology."

THE new research vessel, the R.R.S. *Discovery II.*, a description of which appeared in our issue of Nov. 23, p. 798, has been loading at St. Katherine's Dock, London, and on Dec. 10 she was inspected by H.R.H. the Duke of Gloucester, who evinced great interest in the vessel and her equipment and made a short speech to the officers and crew. On the following day the Discovery Committee held a reception on board the vessel, and on Dec. 12 she was visited by King Haakon of Norway. The *Discovery II* sailed on the morning of Dec. 14, and in a month's time will be at work on the whaling grounds of South Georgia.

LAST summer, Prof. G. Elliot Smith attended as an official representative of Great Britain the Pan-Pacific Science Congress held in Java, and on Dec. 9 he delivered a public lecture at University College, London, describing his experiences. He said that the recent achievements of the Dutch in Java are worthy of careful consideration by everyone interested in colonial administration, and especially in the application of science for the welfare of mankind. As Mr. Ormsby-Gore, referring to Java, said in his recent report, "It certainly affords the most remarkable example in the world to-day of the application of science to the development of the tropics. . . The significance of Java has never been fully appreciated in Great Britain or in the other parts of the Empire." In Java scientific research is regarded not as an expensive luxury but as the vital and essential condition of social and economic prosperity, if not of existence itself. Much important work is being accomplished in both pure and applied science, and not only are the results of research being used for administrative purposes, but in addition the spirit of scientific inquiry inspires the attitude of the government. In no department is the effect of this interest more vividly revealed than in the affairs of the people themselves. No visitor to Java can fail to be impressed by the happiness of the teeming multitudes of well-behaved people—the population of Java roughly equals in number the people of Britain. This is in large measure due to the study of the peoples and their customs and beliefs. The understanding of the mentality of the people of Java which has emerged from the interest in and the scientific study of their history and institutions has enabled their rulers to respect the desires of the population and preserve institutions and customs which mean much to them and do not interfere with orderly government.

APART from these considerations, Java is for the anthropologist a land of intense interest. As the home of the earliest-known member (*Pithecanthropus*) of the human family and of the tree-shrews, tarsiers, lorises, and a variety of monkeys and apes, the Netherlands Indies provide an epitome of man's ancestry. They form the avenue whereby representatives of the most primitive surviving races of men wandered to their homes in Australia and Melanesia respectively. Centuries later, the most adventurous Argonauts of early times made their way through the Archipelago to the scenes of their greatest maritime achievements in Polynesia. Java is the new Atlantis not only in the Baconian sense as the one country where science promises to be the inspiration of

administration, but also in the fact that it is the most important cultural link with the New World. The Malay Archipelago, forming a widely spread group of islands occupying the only means of access to the Pacific Ocean, has throughout the ages acted as a sieve which has retained certain of the elements of the many cultural streams passing from the west out into the great ocean. Repeatedly one sees, not merely on the ancient monuments but also amongst the living population, scores of interesting survivals of the ancient civilisations of China and India, Greece and Mesopotamia, Crete and Egypt, forming an integral part of the modern culture. Inscribed upon the old Indian temples of the eighth and later centuries of the Christian era, there are scores of ornamental designs and other architectural devices the dependence of which upon India and Greece is generally admitted, but which are also assumed by many to be distinctive features of the Maya culture of Central America.

AT a meeting of the Royal Society of Edinburgh on Dec. 2, Prof. V. Gordon Childe read a paper on the early colonisation of northern Scotland as illustrated by the recent discoveries in Orkney. He summarised the variations in climate known to have taken place in Europe since the last Ice Age, pointing out that the most flourishing periods of prehistoric and early historic civilisation in Caithness and Orkney coincided with what should on current climatological notions have been peculiarly unfavourable epochs. On the other hand, historical circumstances lent significance to the position of these lands at the mouth of the North Sea in 'neolithic' times, during the Roman occupation of Britain and in the Viking age. Prof. Childe described the new culture revealed at Skara Brae, Orkney, as the result of divergent specialisation in an isolated area. It was compared in turn with that of each of the periods when Orkney participated actively in the general current of cultural progress. Many features of the architecture of the village can be traced in the 'neolithic' chambered cairns, but the pottery at least is derivable from a definite group found in Scotland during the Bronze Age. The brochs and their culture were examined in great detail, but it is concluded that there are no significant points of contact. The inference is that the village was anterior to the brochs or else represented a renaissance of a purely native culture after the civilisation of the broch builders had fallen into decay. The native culture itself would be derived from the first neolithic colonists coming from the Atlantic, perhaps mixed with Beaker folk from Central Europe. The broch builders represented an entirely new stock, certainly Celtic, but coming immediately from the Western Isles.

IN a Friday evening discourse on Dec. 13 at the Royal Institution by Miss D. A. E. Garrod, on cave excavation in the Near East, it was stated that until the last few years the study of prehistoric remains in Palestine has been practically confined to the collection of material from surface sites. In 1925, Mr. Turville-Petre, excavating on behalf of the British School of Archæology in Jerusalem, discovered a skull of Neandertal type associated with an Upper Mousterian industry in the Mugharet ez Zuttiyeh, north of the Sea of Galilee. In 1928 the British School carried out excavations in a cave near Shukba, in the western Judæan hills, where an Upper Mousterian industry resembling that of the Mugharet ez-Zuttiyeh was found underlying a Mesolithic level, hitherto unknown in Palestine. In the autumn of 1928 a carving on bone, which appeared to be prehistoric, was discovered in a sounding made by the Palestine Department of Antiquities in the Mugharet el Nad, at the western foot of Mt. Carmel, and in 1929 this cave was excavated by the British School, in collaboration with the American School of Prehistoric Research. The outer chamber of the cave was much disturbed, but the inner chamber, which was untouched, contained five prehistoric levels, as follows: 1, Mesolithic; 2, 3, 4, Upper Palæolithic; 5, Mousterian. The Mesolithic represents a slightly later stage of the Shukba industry. In the Upper Palæolithic layers northern African and European influences alternate, the industry of 2 being Capsian, while 3 and 4 contain an Aurignacian of European type.

PROF. H. FREUNDLICH, who delivered the second Liversidge lecture before the Chemical Society on Dec. 12, took as the subject of his discourse "Surface Forces and Chemical Equilibrium". Speaking with delightful clarity and fluency, he said that surface reactions are of the greatest importance in technical and biological processes, but that since these reactions are generally very complicated, it is worth while to examine our knowledge concerning the simple case of a chemical equilibrium being influenced by surface forces. Sir J. J. Thomson's treatise on the application of dynamics to physics and chemistry appeared to him to be the true successor of Gibbs' thermodynamical papers, from which the chemist may still derive many suggestions. Prof. Freundlich first referred to the phenomena accompanying the separation of chloroform by the action of alkali on chloral hydrate, and then extended the inquiry to surfaces of solid substances, illustrating quantitative aspects of the adsorption of fatty acids by charcoal and siloscen, and discussing Frumkin's observations on the adsorptive behaviour of charcoal exposed, respectively, to hydrogen or oxygen. When speaking of the work of Deutsch on the colour change of indicators, Prof. Freundlich showed the striking change of colour of an acid solution of malachite green when shaken with an indifferent liquid such as benzene, and demonstrated the production of a deep red colour when a solution of the colourless base of the dye rhodamine O dissolved in benzene is shaken with water.

ADSORPTION of dyes on silver halides was next discussed by Prof. Freundlich, who also described the experiments of Deutsch and Fajans on the formation of a red precipitate at the interface when a solution of sodium eosinate and silver nitrate is shaken with benzene, pentane, or even air, the equilibrium being shifted in the direction of the undissociated and less soluble salt. Undissociated salt is also formed on the surface of the silver halide, and hence the colour change is the same at all interfaces. Other non-reversible reactions at interfaces result in the forma-

tion of an acid soap on the surface of soap solutions, and in the denaturation of proteins when their solutions are shaken with air or other gases. Prof. Freundlich's experiments with Juliusburger on the bromoethylamine—dimethyleneimine transformation in the presence of animal charcoal were illustrated by curves showing the extent of the adsorption of the four substances (the bases and their hydrobromides) concerned in the process, and the effect of the charcoal on the reaction velocities. It was shown that the equilibrium is displaced in such a way as would be expected from Thomson's relation, the formation of capillary active substances being favoured, and that a substance may be more stable at an interface than in homogeneous solution under similar conditions. Concluding with a consideration of the significance of interfaces in biological problems, Prof. Freundlich said: "The fact that substances are formed at interfaces, and are stable there, which are rather rare under the same concentrations without the interfaces may account for the extraordinary structure of many substances which are biologically important . . . I should not be surprised if the great difficulty which we meet in trying to explain the nature of enzymes is partly due to similar causes. They may be very unstable and active organic substances, perhaps even organic radicals, which are stabilised because they are adsorbed at a suitable interface, but are able to react very energetically in intermediate reactions with other substances also adsorbed on these interfaces."

THE presidential address of Engr. Vice-Admiral Sir Robert Dixon to the Institute of Marine Engineers on Dec. 10 was an authoritative review of the trend of marine engineering during the last few years. As his career as a student began in 1882, and from 1922 to 1928 he was Engineer-in-Chief of the Fleet, Admiral Dixon has been concerned with all the revolutionary changes of the past half-century, while to day he is actively identified with the development of high pressure steam marine plant. But however much one would like to see steam retain its supremacy the challenge of the oil engine is unmistakable. In the past decade the total tonnage of motor-ships has risen from 700,000 to 6,000,000, and there are ships now running with engines of 20,000 and 25,000 horse-power. It is the high thermal efficiency which has enabled the oil engine to compete successfully with the best steam plant, and if steam is to maintain its position in our mercantile marine the improvements suggested by Admiral Dixon as to mechanical firing, large water-tube boilers, and higher steam pressures are bound to come. There are inherent possibilities in the steam engine cycle which have not even yet been fully explored.

THERE are many factors in the problem of what is the best type of machinery for any particular ship, two of which are weight and fuel consumption. The steam machinery of the *Empress of Canada*, said Admiral Dixon, weighs 380 lb. per s.h.p., while in the *Duchess of Bedford*, built six years later, it was only 282 lb. The corresponding figure for the *Nelson* and *Rodney* was 100 lb., for the *Hood* 81 lb., for the 10,000-ton cruiser 45 lb., and for destroyers, 33 lb. Early Diesel engines weighed 450 lb. per b.h.p., but in a modern liner the weight is only 155 lb., while large submarine engines working on the single acting four-stroke cycle have been built weighing only 50 lb. per h.p. As regards oil consumption in motor-ships, this runs from 0.4 lb. to 0.44 lb. per horse-power per hour, while in the oil fired steam vessel *Duchess of Bedford* it is 0.57 lb., and this could possibly be reduced with the latest machinery to 0.5 lb. Boiler oil is, of course, cheaper than Diesel oil, and coal is far cheaper than either. The address showed that Admiral Dixon has great faith in the power of our designers to meet the needs of the time, while towards the end of his address he threw out the pregnant suggestion that even the screw propeller as we know it to-day may be superseded, for "the experiments with modern high-speed pumps and hydraulic devices suggest that such a device, comprising possibly a multi bladed system, is not outside the bounds of possibility".

LAST summer the Institution of Electrical Engineers was specially invited to visit the Pyrenees and inspect the interlinked group of electric generating companies which supply power to the Midi Railway and the chemical and metallurgical factories in the south of France. On Nov. 4 the technical lessons to be learned from this visit were discussed at the Institution. The hydro electric power developed in south-west France amounts to 340,000 kilowatts, and this is supplemented by 122,000 kilowatts generated by thermal stations. All the generating companies, including the Midi Railway Company, are interconnected electrically. They are controlled by a central organisation. A 'load-dispatcher' located at Tarbes is in telephonic communication with all the stations and works. Arrangements made with the works only allow them to be supplied with current at times convenient to the generating company. By this means the latter can arrange so that it only supplies at practically full load, and so the charge for power is very low. The plants are so designed that they can be put in or taken out of service at short notice. Formerly, for example, calcium carbide furnaces required a fortnight to get into full operation, now they only require about three days. Works which can utilise surplus power during flood seasons get it very cheaply. In the Valleé d'Ossau, every effort is made to utilise all the power available. Three generating stations are installed. The highest station utilises the fall between 6400 feet and 3670 feet. The next uses the fall to 2372 feet; and the lowest, the station at Hourat, uses the fall from the middle station to 1681 feet above sea-level. The change over to electricity does not seem to have benefited the railway much, but it is a national gain to obviate the purchase of foreign coal.

THE Electrical Contractors' Association has done useful work in publishing a little book entitled "Electrical Installation Work." Reasons are first given why architects and the public should take greater interest in the electrical equipment of buildings. The uses of electricity are now so varied that the lighting load taken by a consumer is often only a fraction of his total supply. In addition, the public supply of

electricity is passing through a period of radical change and development The standard voltage for domestic supply has now been fixed at 230 and low-pressure direct current systems are gradually being converted into alternating current systems at this pressure The illumination now demanded is often ten times as great as the average illumination ten years ago An electric fire takes as much current as a hundred of the old 8 candle-power carbon filament lamps and an electric cooker may take as much as 400 of these lamps. Modern electric wiring, therefore, has to be installed with much greater care than the systems used twenty years ago If it is done by a reputable firm which belongs to the Contractors' Association, the consumer can be reasonably certain that the risk of shock has been reduced to a minimum and that the fire risk is almost negligible. It is advisable that all extensions of the wiring should only be done by competent wiremen. It is a comparatively simple operation to add a few lamps to a circuit, but this must only be done when it is certain that the existing wires can safely carry the existing load. The greatest caution should be used in connecting eliminators and rectifiers for use with radio receiving sets to the house mains When head phones are used there is a risk of shock. It is best to have the 'all electric' receiving sets installed by an electrical contractor.

The ordinary signalling systems used on railways suffer from two defects They depend on the engine driver observing an optical, or acoustic signal, and they depend also on his acting in the way indicated by the signal The possibility of error by the human element therefore comes in twice. Several systems of signalling have been devised which can, when necessary, automatically bring the train to rest or reduce its speed. The drawback to most of these systems is that they depend on an elaborate network of wires and apparatus on the track, and supervision of them is consequently expensive. A revolutionary system of optical signalling is at present working on several hundreds of miles on the German State railways between Munich and Berlin. An account of this system is given in the *Electrical Times* for Dec. 5. On the front of every locomotive is fitted a powerful lamp which continuously throws a narrow beam of light almost vertically upwards. On the signal posts beside the track a specially designed mirror is fixed which reflects the beam on to a circle of which the middle of the lamp lens is the centre. A number of selenium cells are placed at intervals round the circumference of this circle and for various positions of the mirror different cells are illuminated. Each of these cells gives a different signal to the engine driver. A perforated disc driven by a motor breaks up the light stream into 600 light impulses per second and the apparatus only responds to this interrupted light. This prevents it being actuated by other light sources. The driver's recognition of the signal is not a momentary glimpse. It remains under his observation until either he acts on it or, if he has waited too long, the brakes automatically stop the train.

That there is room for an authoritative periodical dealing with metallurgy in all of its rapidly developing phases and forming a link between research and the industry there can be little doubt. Even as an avenue of publication, auxiliary to the journals of the recognised metallurgical societies, there is scope for such a paper In so far as *Metallurgia*, the first issue of which has just made its appearance, can fulfil these functions, it deserves, and will receive, a whole hearted welcome. We have in Great Britain nothing of the standing of say *Stahl und Eisen* or the *Revue de Metallurgie*, and the gap in our metallurgical literature is one which should be filled Among the contents of this first number are Parts I of articles on refractory materials, the principles and uses of wire ropes, and the heat-treatment of metals by electrical means. Other subjects dealt with include tungsten carbide tools, the Ford foundry at Cork, acid resisting steels, bearing bronzes, etc It is clear, therefore, that the producers have in mind the needs of the engineer as well as those of the metallurgist himself. Among forthcoming articles which are announced may be mentioned the discussion of high chromium irons and steels, welding, light alloys, casting methods, etc The get-up of the paper is excellent, the diagrams and illustrations are both exceedingly well reproduced, and the venture is one which will be watched with the greatest interest and goodwill

An essay by Mr G. G Coulton entitled "Modern Faith", which deals with "the spiritual problems confronting the younger generation", appears in the December number of the *Realist*. Although fifty years ago doubt about the tenets of the accepted religion often needed a good deal of courage, "at present doubt is unquestionably the line of least resistance for a young man". Yet, though the line of least resistance may be the true line, "the thoughtful mind will be on its guard against it". As Fénelon said, "He who fears excessively to be duped deserves to be duped, and he nearly always does get grossly duped". Mr. Coulton is inclined to take Renan's view that very few people are entitled to criticise Christianity. "No man has a moral or intellectual right to treat Christianity as negligible unless he has attentively faced its history and its present position in society, and found solid reasons for supposing that its past and present hold over men can be explained away." It may be natural, but it is highly regrettable, that the best minds should alienate themselves from the life of religion because of "the crudity and falsehood of certain religious manifestations". A similar policy of abstention from politics is equally disastrous, and is becoming quite as common. We may affect to despise Christianity, yet in it "there is one characteristic which is removed by a whole horizon from vulgarity. It has always been specially rich in that type which we understand under the name of *saint*". These are things which the present generation is too apt to overlook, in natural reaction from the excessive claims, and sometimes the false pleas, of earlier Christian generations. The phenomenon of Christianity, whether as a historical influence in Europe or as a not extinct power to-day, deserves at least as much attention "as we who cannot understand relativity render willingly to Einstein's theory".

THE inadequate harmony between the cultural and scientific points of view is also the theme of Prof Lancelot Hogben's article in the same issue of the *Realist*, though he treats the subject from a very different aspect He pleads for ' a new humanism which takes as its starting-point the position of man in the physical universe as it is apprehended through the medium of scientific method ". He is of the opinion that such a strictly scientific humanism ought to have been the goal of the Renaissance, which somehow got sidetracked into literary and philological studies, neglecting those developments of Greek science which had taken place under Arabian influence during the thirteenth century. The sudden collapse of this Arabian culture certainly presents interesting problems. Renan attributes it to the philosophers having been courtiers, so that when sovereigns became fanatics for Mussulman orthodoxy, the *savants* disappeared and their manuscripts were burnt. It is clear that Prof. Hogben underestimates the difficulties of basing a rich culture purely upon the natural sciences. It is not only that, as Sir James Jeans has recently reminded us, " the ultimate realities of the universe are at present quite beyond the reach of science, and may be—and probably are—for ever beyond the comprehension of the human mind ". A yet more fundamental difficulty is that science cannot supply that *qualitative* point of view which is the first condition of any consistent attitude to life We must have values, but science would cease to be science if it introduced them. Prof. Hogben's hostility to metaphysics has caused him to simplify unduly the problems which he strives to solve But his plea for the study of the *history* of scientific research, as well as of its methods and results, is one for which we have every sympathy.

THE eighty-sixth meeting of the American Association for the Advancement of Science will take place on Dec. 27–Jan. 2 at Des Moines, Iowa. According to a preliminary programme which has appeared in *Science*, this is only the seventh occasion on which the Association has held its annual meeting west of a line joining Chicago, St. Louis, and New Orleans, and is the first time that it has met at Des Moines. The new president of the Association is Dr. Robert A. Millikan, director of the Norman Bridge Physical Laboratory, California Institute of Technology, Pasadena, and his address will be entitled " The Alleged Sins of Science ". The retiring president, Prof. Henry Fairfield Osborn, president of the American Museum of Natural History, New York City, will speak on " The Discovery of Tertiary Man ". A general session of the Association will be devoted to the economic aspect of the present status of scientific workers. A general exhibition of apparatus, materials, and books relating to science will be open during the meeting.

AMONG recent appointments in the Colonial agricultural services are the following: Mr. F. W. Hall, plantation manager, Agricultural Department, Uganda, to be assistant director of agriculture, Gambia; Mr. J. R. Mackie, deputy assistant director of agriculture, Nigeria, to be assistant director of agriculture, Nigeria; Mr. R. W. R. Miller, senior agricultural officer, Tanganyika Territory, to be director of science and agriculture, Barbadoes; Mr W. Cook, to be entomologist, Agricultural Department, Gold Coast, Mr J. Wright, to be mycologist, Agricultural Department, Gold Coast; Mr A. B S. Ransford and Mr. E. W Gaddum, to be assistant agricultural officers, Kenya; Mr. A. V. Gibberd, to be superintendent, Agricultural Department, Nigeria, Mr R. J Sutton, to be produce inspector, Nigeria; Mr R H. Fraser, to be agricultural officer, Northern Rhodesia; Mr. H. M. Heald, to be agricultural officer, Department of Agriculture and Forests, Palestine; Mr B J. Hartley, Mr. J Robertson, and Mr F. R. Sanders, to be district agricultural officers, Tanganyika Territory; Mr. C. W. L Fishlock, to be agricultural officer, Uganda. Some recent appointments made by the Secretary of State for the Colonies in the forestry services are: Mr. J R Ainslie, deputy director of forests, Nigeria, to be director of forests, Nigeria; Mr. N. V. Brasnett, assistant conservator of forests, Kenya, to be conservator of forests, Uganda; Mr G. W. Chapman, to be assistant conservator of forests, Cyprus; Mr. G. C Beaven, to be assistant conservator of forests, Gold Coast, Mr. I. D S. Cameron, Mr P. C. Lancaster, and Mr. K. R. MacDonald, to be assistant conservators of forests, Nigeria.

MESSRS. Newton and Co., 72 Wigmore Street, London, W.1, have sent us a copy of their catalogue of optical lanterns, epidiascopes, and other projection apparatus. This includes kinematographs, and projection polariscopes and spectroscopes, lamps, resistances, screens, and so on. It is worth while noting that lanterns can be hired, with or without an operator.

THE Annual Report for 1928 of the Rockefeller Foundation by the president, Mr. George E. Vincent, has been published. It records and surveys the world-wide activities of the Foundation in the realm of public health and preventive medicine and in the cause of public health education. The merging of the Rockefeller Foundation and the Laura Spelman Rockefeller Memorial into a new corporation to be known as the Rockefeller Foundation is also reported. The new Foundation's activities will now include not only public health, but also the advancement of knowledge in the medical sciences, in the natural sciences, in the social sciences, and in the humanities.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A pathologist and bacteriologist in the Giza Memorial Laboratory, Cairo—Sir Holburt Waring, 37 Wimpole Street, W.1 (Dec. 30). Clinical assistants (senior and junior) in the Medical, Surgical, and all Special Departments of the Royal Free Hospital—The Secretary, Royal Free Hospital, Gray's Inn Road, W C.1 (Jan. 4). A principal and professor of medicine at the Veterinary College, Patna—The Secretary to the High Commissioner for India, General Department, 42 Grosvenor Gardens, S.W.1 (Jan. 15). A senior clinical assistant and clinical tutor at the Royal Infirmary of Edinburgh (Ophthalmic Department) and two clinical assistants—The Superintendent, Royal Infirmary, Edinburgh. Civilian education officers in the R.A.F. Education Service—The Secretary, Air Ministry, Gwydyr House, Whitehall, S.W.1.

## Research Items.

**Early Man in India.**—In a report by Col. Seymour Sewell and Dr B. S. Guha (*Memoirs, Archæol Survey*, No 35, App 5), the bones excavated at Nal, in Baluchistan, by Mr H Hargreaves of the Archæological Survey and attributed by Sir John Marshall to the chalcholithic age, are described and their possible affinities discussed. Of two crania described by Sir Arthur Keith, one, the 'Sialkot' skull, probably belongs to much the same period as the bones from Nal These consist of fragments representing thirteen individuals, of whom some were children With the human remains were bones of birds and mammals, part of a large and remarkable bone pin, and some fragments of pottery Part of an adult skull was found The greater part of the left side of the skull is missing, as is the lower jaw It is markedly dolichocephalic, having the low index of 70 This may be due to a slight posthumous flattening. A crescentic piece of flatly ground limestone was wedged at the back of the hard palate It is suggested that this is an early form of the Indian custom of placing a gold coin in the mouth and of other methods of occluding the mouth and nostrils to prevent the escape of the soul The teeth are large and well formed, but very much worn down by a hard diet. The long bones show the flattening usually attributed to life in a mountainous region. Owing to the scarcity of types of this early period, it is difficult to suggest physical affinities. The closest resemblance is to the dolichocephalic type from Kish, except that the Nal skull has a much higher vault Of the two types found at Mohenjo-Daro, the dolichocephalic also resembles the Kish type, but the brachycephalic appears to be Mongoloid rather than Armenoid, as has been suggested for the Kish brachycephal.

**Skull of Ornithorhynchus.**—Dr. Kesteven and Mr. Furst (*Jour. Anat.*, vol 63, pt. 4, pp. 447-472, July 1929) give the first complete description, in the English language, of the skull of the platypus, based on a series of nine skulls, from a fœtal skull measuring 25 mm , to the skull of an old adult. Such a complete series has enabled the authors to work out the development of the skull, and to correlate features of the early skull with those of the adult. They show, among other features, the extent and situation of the presphenoid and ethmoid ossifications, and have discovered that the squamosal bone is excluded from sharing in the formation of the inner wall of the cranial cavity. They believe that an independent lachrymal bone is present as a separate entity in the youngest skull, and is still recognisable up to a skull measuring 65 mm. A discussion on the significance of the alisphenoid lamina of the periotic bone is added by the senior author.

**Migration of Sea Animals to Land.**—Mr. A. S. Pearse ("Observations on Certain Littoral and Terrestrial Animals at Tortugas, Florida, with special reference to Migrations from Marine to Terrestrial Habits." Papers from the Tortugas Laboratory of Carnegie Institution of Washington, vol. 26, No. 6) makes some interesting experiments and observations on the ability of certain littoral animals to live in fresh water and on land. In their natural surroundings the sea animals of the Dry Tortugas have little or no opportunity to migrate to fresh water, but there are several crabs and hermits which are adapted for living in more or less dry situations. These form a series which inhabit all grades from sea to land, culminating in the land hermit, *Cenobita diogenes*, which lives far from the shore and can do without gills at all, as the author has shown by experiment Crabs that have migrated landwards show a progressive lessening of gill volume, sometimes developing respiratory tufts on the lining of the branchial cavity As is stated, "An ideal animal is air-breathing, water conserving, swift, and internally stable" As an example of such an animal that has migrated from the sea, the crab *Ocypode* is instanced, which is swift, aggressive, more or less diurnal, and spends most of its time on land. It is omnivorous and a scavenger, and has lost a third of its gills and developed branchial tufts An interesting point about this crab is the absence from its gills of parasitic mites which occur on some of the other land crabs The habit which *Ocypode* has of bathing at intervals in the sea is given as the reason. A separate paper by the author in the same publication (No 6) describes two of these mites which are new to science.

**Experimental Research on Freshwater Plankton.**—An important summary of research methods in freshwater plankton laboratories is given in Band 6, 1929, of Dr August Thienemann's "Die Binnengewasser", which is wholly occupied by Dr Einar Naumann, Director of the Swedish Limnological Laboratory of Aneboda, in his "Grundlinien der experimentellen Plankton-forschung". The author explains the aims of these laboratories, giving particulars of all researches in every aspect. Throughout, the importance of ecological work is emphasised, and details of methods both in field and laboratory are fully discussed The laboratory at Aneboda is first briefly described as an example; all terms which have to do with limnological study are defined, and figures of apparatus and tables of reagents for analysis of the plankton, both living and dead, are given. Further sections discuss suitable waters for the laboratory, testing methods, and the regulation of the chemical constituents of water, including the estimation of $pH$, lighting and heating, plankton as food, and the feeding of the plankton organisms; finally, details of plankton culture both in the laboratory and in the open, and problems of plankton research. The cladoceran *Daphnia magna* is very much used in these researches, besides copepods, rotifers, and unicellular organisms, both plant and animal The whole work is extremely useful to all those who have anything to do with limnological studies.

**Japanese Bryozoa.**—Mr. Yaichurô, Okada, in his "Report of the Biological Survey of Mutsu Bay, 12. Cheilostomatous Bryozoa of Mutsu Bay" (*Science Reports of the Tôhoku Imperial University*, 4th Series (Biology) Sendai, Japan, vol. 4, No. 1, Fasc. 1, February 1929), continues his survey of the Bryozoa. This is one of the contributions from the marine biological station at Asamushi, Aomori-Ken, and is the second paper on this group by the same author. In the present instalment only the Cheilostomata are described, twenty-seven species in all, six of which are apparently new These latter include one species of *Ellisina*, two of *Caberea*, one of *Lepralia*, and two of *Micronella*. In *Costazzia costazi* Audouin, which was very common, it was noticed that the zoœcium exhibits a variable outer configuration, forming frequently a cubical mass, infrequently a discoidal convex thickened mass, and occasionally an encrusting mass. So far as these outer characters are concerned they might be regarded as distinct species, but from the characters of the zoœcium they are found to agree and are therefore all included under one species.

**Appearance of *Phormia* in *Calliphora* Cultures** —Prof E A Bogdanov (*Nauchno Agron Zhurnal*, Moscow, No 7 8, 1929) records some very interesting observations on the appearance on six separate occasions of the fly *Phormia coerulea* in the pure cultures of the *Calliphora erythrocephala* The conditions of breeding of the latter (for genetic studies) were such that a contamination of the culture by the eggs of *Phormia* is considered exceedingly improbable Moreover, the *Phormia* flies obtained in the laboratory differed physiologically from the wild flies of the same species, which could not have happened if they were their direct descendants The main feature of the laboratory-bred *Phormia* is their inability to propagate further, while the wild fly is extremely prolific, other characters of the laboratory flies indicate also a considerable degree of degeneration, generally in the same direction as in the case of other mutants of *Calliphora* Very remarkable is the fact that some females of the laboratory *Phormia*, though unable to propagate with their own males, produced fertile progeny with the males of *Calliphora*, and the hybrids of the first generation were indistinguishable from the normal *Calliphora*, thus the laboratory *Phormia* proved to be completely recessive to *Calliphora* This can only occur in a case of a true mutation. In the following generations there was no uniformity, and most of the flies were pathological, but clearly belonging to *Calliphora*, in one case, however, a *Phormia* was obtained in the second generation The author does not insist that the transmutation of one genus into another has actually taken place and is prepared for some other explanation. His main object in publishing the observations is to attract the attention of other workers on *Calliphora*, since it is probable that when similar cases are observed, they are attributed to an accidental contamination and not investigated in detail

**Newer Tertiary Fossils from the Dutch East Indies** —Collections of Newer Tertiary fossils from the Dutch East Indies are described by F. Siemon (*Ber Naturf. Gesell. Freiburg i Br.*, Bd. 29) One series was obtained on two expeditions, in 1907 and 1909–10, from the south-west of Dutch New Guinea in the regions drained by the North River, the Bibis River, and the North-west River. Twenty-two species of mollusca, two being new, with a few corals and foraminifera, as well as a selachian (*Carcharias gangeticus*, Mull ) are recorded and tabulated from Miocene and Pliocene deposits Two text maps and half-tone figures from photographs of the new species accompany this part. Another series of fossils was collected by Prof. G G L. Kimmerling in the neighbourhood of Cheribon in Java, and these are dealt with station by station In age they range from the Eocene upwards.

**Observing Sea Temperature.**—In discussing the reliability of various methods of taking the surface temperature of the sea (*Journal of Washington Academy of Sciences*, vol. 18, No 20), Mr E F Brooks notes that, with all its faults, the bucket method affords the only practical method for general use. It is useful, therefore, to note some of the sources of error that are likely to occur. The first source of error is that the bucket is unlikely to have the same initial temperature as the water. this may mean an error of 0·1° C. Then, again, the water sample may be cooled by evaporation and conduction. The conduction cooling can be prevented by a rubber covering two to four millimetres in thickness. Evaporation is less easy to check and may account for a fall in temperature of 0·5° C. The thermometer generally used has a metal case which may have an appreciable effect, but the case can be removed and this error thus obviated A quick responding thermometer is advisable to prevent the likelihood of a false reading, and for the same reason the thermometer should be read while in the water A few other minor sources of error are noted Mr Brooks also shows that experiments have proved that in calm weather the temperatures at the surface and at a depth of 5-8 metres vary within 1·5° C In rough water, however, there is little difference, and a thermograph attached to the condenser intake should give reliable surface temperatures.

**Afforestation and Stabilisation in Granada.**—The publication of the *Instituto Nacional de Investigaciones y Experiencias Agronómicas y Forestales* (Año 2, Núm 3, Madrid, 1929) contains several articles of interest To a country possessing so little forest as is the case in Spain, one of the most important is a project for the correction and stabilisation of certain tracts of land in the Province of Granada, by J M Garcia Nájera, a mountain engineer The author, after briefly discussing points justifying the scheme, proceeds to describe the geology of the area and the causes of instability. The primary cause, probably dating back several centuries, was the ruthless disafforestation practised, accompanied by and completed by fire and the pasturage of animals—especially goats The engineer of course regards the matter from the point of view of the conditions actually existing, and they demonstrate the necessity of governments considering this question of erosion and denudation in mountain regions due to the absence of protection by existing forests For present neglect will not only prove directly injurious to the descendants of the existing populations practising wasteful methods of utilisation, but will also result in heavy expenditure, which Spain is now undertaking in the stabilising work herein dealt with The author discusses the various possible means for dealing with the instability and his proposed solution. This involves the construction of a main dyke, channels for intercepting water, embankments and trenching work and general drainage schemes Lastly, plans of afforestation are dealt with and the establishment of rain gauges on the area. The article is illustrated with some excellent photographs and several plans depicting the works to be undertaken

**Repulsion of Atomic Kernels.**—In the November number of the *Journal of the American Chemical Society*, W. M. Latimer has considered organic rearrangements from the point of view of the change in the repulsion of the atomic kernels which results from the chemical change and has arrived at the following conclusions. The great majority of rearrangements take place with a decrease in the inter-kernel repulsion energy, a few occur with no change in repulsion energy and are then regarded as resulting from a state of high activation of the molecule, and the product is a mixture of the two forms. Rearrangements with an increase in repulsion energy are rare and invariably accompanied by complex redistributions of electrons in the molecule. The observations are in accordance with the following premise: if there are several possible arrangements of the atoms in a molecule which have the same number of electrons per atom and satisfy equally well the tendencies of the more electro-negative elements to complete their octets of electrons, that form will be the most stable which gives a minimum of repulsion between the atomic kernels.

**Permeameters, Rods and Strips.**—The general principles of permeameters for testing rods and strips of iron by the use of a yoke to provide a return path for the magnetic flux are well known. The main diffi-

culty of such apparatus is to approximate sufficiently closely to the condition of uniform magnetisation which is assumed in the formulæ To effect this, various means for compensating for lack of uniformity have been devised With a uniform specimen, complete uniformity of magnetisation involves equality of magnetic potential and absence of magnetic leakage The Iliovici permeameter tests the first condition and the modified form of Picou permeameter the second In the November issue of the *Journal of the Institution of Electrical Engineers*, C E Webb and L H Ford describe precision permeability measurements on straight bars and strips in the region of high permeability The construction of a yoke apparatus to give magnetising forces up to $H = 3000$ on straight samples 25 cm long and up to $H = 5000$ on straight samples 10 cm long is described Search coils are used to measure the magnetising force and the conditions for satisfactory compensation for leakage are determined It was found that solid bars were less liable to the effects of stress than sheet samples, but slightly bent or twisted specimens clamped between flat blocks give rise to serious errors When search coils are wound directly on the sample, sheet material rings are very liable to be stressed The errors due to variation in the reluctance of the path of the magnetic flux can be avoided by limiting the number of strips in the sample to ten, provided that they be accurately cut to a uniform width For values of $H$ greater than 15, the effects of stress and variation of reluctance become negligible

**Reactions of Atomic Hydrogen**—The action of atomic hydrogen prepared by Wood's method on a number of organic compounds has been studied by Urey and Lavin, whose results are published in the November number of the *Journal of the American Chemical Society* Atomic hydrogen is, on the whole, a rather mild reducing agent It reduces azoxybenzene at least partly to azobenzene and azobenzene partly to hydrazobenzene, with aniline as a final product. Certain solid dyes are reduced to colourless compounds which are partly oxidised again to the coloured form on exposure to air Benzoic acid and acetamide catalyse the recombination but are not noticeably reduced Atomic hydrogen recombines in the presence of formic acid A small amount of formaldehyde is produced, probably due to the decomposition of the acid by heat into water and carbon monoxide and the subsequent formation of the aldehyde from carbon monoxide and atomic hydrogen Acetaldehyde is polymerised to paraldehyde.

**Vapour Pressure of Rubber Jellies.**—In the October number of the *Journal of the Chemical Society*, P. Stamberger describes experiments on the vapour pressures of rubber jellies in three solvents; benzene, chloroform, and carbon disulphide. Up to a certain concentration the rubber causes no appreciable vapour pressure lowering, but beyond this the lowering increases rapidly with concentration. This result is quite different from that with 'true solutions' (molecular dispersions), for which a linear relation with concentration holds up to high concentrations. The results with different samples of rubber agreed, thus suggesting that rubber is probably a definite hydrocarbon and not a mixture of hydrocarbons of different degrees of polymerisation. The results are interpreted on the lines of the formation of solvated layers and not swelling by capillary forces. During the first stage of the process it is assumed a layer of solvent molecules is formed around the rubber particle, leaving free solvent to exert the normal vapour pressure. In the solvated layer solvent molecules exhibit vapour pressure lowering. The results are shown to favour the assumption that the rubber molecules are long chains and this type of molecule seems to be characteristic of substances which show swelling

**Liquid Crystals and Chemical Constitution**—The property possessed by certain chemical compounds of forming liquid crystals has been studied by D Vorlander, who attempts in two papers in the November issue of the *Berichte der Deutschen Chemischen Gesellschaft* to correlate this property with certain deductions as to the relative orientations of two or more long chains of atoms to one another It is shown that the non-appearance of liquid crystals in such derivatives of urea and thio urea as are obtained by introducing two *p*-amino *p'* ethoxyazo benzene groupings into the molecule may be due to the angular divergence of these two long groups, which are linked together by the carbonyl or thiocarbonyl group at an angle of 109° When, however, these compounds are converted to the corresponding di-imide by removing water (or hydrogen sulphide), this divergence disappears, since the double linking of each nitrogen atom to the central carbon atom results in a linear configuration -N=C=N- and the compound can exist in the liquid crystalline condition. This evidence is confirmed from a study of the esters which trimesic acid and the three phthalic acids produce with such lengthy chain compounds as *p*-phenetoleazophenol. The star-shaped orientation of the trimesic esters and the angular divergence (60°) of the chains in the ortho-esters seem to preclude the possibility of liquid crystal formation. The meta-esters with a divergence of 120° melt to liquid crystals which persist only over a short temperature-range, whilst the para-esters, in which the two chains are said to lie in a straight line, are described as supracrystalline, that is to say, the liquid crystalline condition is so stable that the amorphous liquid state is not even attained.

**Voltage Control of Large Alternators.**—One of the difficulties which electrical engineers have to overcome is to maintain the voltage constant at an alternator's terminals when large loads are suddenly thrown on or off. An alternator requires direct current excitation, and its voltage is regulated by varying the current given by a direct current machine. The magnetic circuit of the alternator does not respond instantaneously to a change in the exciting current. The magnetic circuits of large machines store a large amount of energy, and consequently there may be a lag of a second or two in responding to the changes of the exciting current made necessary by sudden changes in the load. H. W Taylor discussed the voltage control of large alternators in a paper read to the Institution of Electrical Engineers on Nov. 28. Voltage control is now required to be automatic within one or two per cent of its normal value. The author discussed the action and reaction of the two machines. In certain cases the alternator voltage is unstable, as, for example, when the load consists of a large overhead network on a light load or unloaded underground cables. In these cases the voltage can rise to a high value. Methods are given in the paper for computing the curve of falling voltage when a sudden load is thrown on the circuit. Modern voltage regulators act only on the field circuit of the exciting dynamo. The alternators have such large exciting currents that it would be impracticable to operate the very heavy contact pieces that would be required to vary their magnitude An interesting oscillograph record is given of the transient variation in the field current when a change in the nature of the load changes the magnetic flux of the machine.

## British Museum Expedition to British Honduras.[1]

By T A JOYCE

THE objective of the British Museum Expedition to British Honduras this season was the group of ruins situated between the Pusilha and Joventud branches of the Mojo River in British Honduras A preliminary investigation of the area had been made in 1928 by Capt. E. L. Gruning, Dr T Gann, and Mr. H. Clive-Smith. The primary objects this year were to bring back as many as possible of the inscribed stone stelæ; to excavate a cave which gave indications of having been used as a pottery dump, to survey the main site so far as possible; to carry on excavation in the numerous mounds, and to prospect for other ruins in the neighbourhood I was accompanied by Capt E. L Gruning, who undertook supervision of transport; and by Mr. Robert Ashton, who looked after the commissariat.

The expedition sailed on Jan 31, and reached Punta Gorda, the jumping off place, on Feb. 23, leaving for Pusilha on Mar. 4.

The cave appears to be a natural cavity in a limestone outcrop of some size, on the summit of which were a series of low mounds. Some of these mounds were excavated, but yielded no results beyond fragments of coarse domestic pottery, and the natural inference is that they were hut foundations. Entrance to the cave was made laterally from the lower level, but the opening here may be of comparatively late date, and produced by the fall of a large tree tearing away the side of the cavern. A kind of 'chimney' leads from the cave to the surface of the outcrop. It seems probable that this chimney was the original means of access to the cave, and that the ancient inhabitants of the village erected on the summit of this outcrop used this 'oubliette' as a convenient dump for broken and discarded pots. Yet it is quite possible that the cave was also, in a sense, a sacred place, because traces of five burials were found there However, these burials may be intrusive

The cave measures some 33 feet in length, and at its widest transverse diameter, 12 feet. Excavation carried down to the rock floor showed that the deposit measured some 10 feet in depth The contents of at least one-half of the cave were removed in layers of approximately 1 ft. 6 in. to 2 ft. in depth. The soil in the cave was heavy and sticky from the surface to a depth of about 3 feet. Below that it was fairly crumbly, and easier to work and search.

When half the cave had been partially excavated to the depth of about 7 feet, it became apparent that the archæological strata were not horizontal but curvilinear, the richest finds appearing immediately under the chimney. It is evident, therefore, that the greater part of the remains had been thrown down the chimney, forming a mound.

The results may be summarised as follows: The main bulk of the remains discovered consisted of pottery fragments of great variety The greater portion consisted, naturally, of coarse domestic ware, so-called 'ollas' and dishes But there was an unusually high percentage of bowls and tripod plates painted in slip, and frequently bearing hieroglyphic inscriptions. The quality of paste is extremely variable, ranging from a rather thick and friable ware to a very thin, hard, and perfectly fired pottery. The slip decoration comprises two or three shades of red, yellow, orange, and black Most of the designs are outlined in the last.

Occasionally a peculiar grey colour is incorporated in the design, a grey which verges on blue, especially when it is combined with one of the more brilliant reds Certain fragments, few in number, show the remains of a thick turquoise-blue slip, rather coarse in quality, which was evidently applied to a completed pot and subjected to a secondary firing. This slip, which bears a remarkably close resemblance to the blue slip characteristic of Mexican Toltec ware, is for the most part imperfectly fired, and only survives in patches This secondary slip, in a colour (and material) which has usually been associated with the Toltec period of Mexico, appears only in the lower strata of this cave, and seems to have been more or less experimental. There can be no question that the pottery of this cave antedates the Toltec period by centuries, and there is not the slightest indication of Mexican influence throughout the complex.

A chocolate-coloured ware, deepening to black, with impressed or incised ornament, thin walls and well fired, appears in small quantities in most of the layers. Incised and 'fluted' ware came from the lower strata. Engraved pottery (on which designs had been carved after firing, or at least sun-drying), also belonged to the lower strata

The depth of the deposit provided six strata, of 1 ft 6 in. to 2 ft each, and these were numbered from 1 to 6 in a downward direction. By far the richest stratum was the fourth, in which examples of practically every style were found. The top stratum, consisting in the main of comparatively recent vegetable humus, was poor in remains apart from coarse domestic pottery. The remains characteristic of the deepest three strata include bowls of rather thick ware, painted with designs in black on yellow. So far as my knowledge goes, this ware has not been found at any other site. Here, too, were found fragments of polychrome ware, many of them well fired, ornamented with series of stepped coils or frets, a design which appears to have gone out of fashion in later times. The same statement is true of the fluted ware. The use of the peculiar grey slip, mentioned above, appears to start in the fourth stratum and continue until the second, while the turquoise-blue slip, probably involving a second firing, belongs to the fourth and fifth The incised ware, though comparatively scanty, belongs to the third, fourth, and fifth strata, but the rare engraved fragments only to the fourth and fifth.

Decorative motives derived from the vegetable world have hitherto been regarded as very rare in Maya art, but the Pusilha potters made great use of a design resembling a twisted liana with dependent buds. This design, which lasted from the fifth to the second stratum, is particularly characteristic of the site and is more frequently met than any other. Another 'vegetable' design, of flower-petals, is also found in the second, third, and fourth strata.

Associated with these upper strata (second to fourth) is a very interesting class of ware in which the designs, usually formal, are painted in a singularly brilliant red on a buff ground. Some of this ware is magnificent from a technical point of view. In many cases the paste is marvellously thin and light, perfectly fired; and the slip-decoration is so highly burnished that it gives the illusion of a glazed surface. The rare pale grey slip appears on vessels of this class, emphasising details; and some of the vases show a stippled ornament in red, which must have been applied by means of a stiff-bristled brush or its equivalent.

As regards the animal world, figures of monkeys are shown on fragments from the fourth and fifth

[1] From a paper read at a special meeting of the Royal Anthropological Institute on Dec. 10.

strata, and also birds The finest piece of painting was a single fragment, which in style recalls the art of Palenque, discovered in the sixth stratum A number of tiny bowls, of very rough ware, often in the form of birds or animals, were found in the middle strata These may have been votive offerings, or, more probably, children's toys

As regards the plates, tripod and plain (with a simple ring foot), the ware is thicker and coarser than that of the bowls, and the feet, where present, are of the cascabel pattern, hollow, and enclosing a small clay pellet which forms a rattle The rims are usually surrounded with a band of painted design, based on textile art, or the 'twist-and bud' pattern, often supplemented with a row of glyphs The centre is usually occupied by a formal design (often cruciform), but sometimes by the figure of an animal or snake or human being

Apart from fragments of *metates* and *manos* (the tripod slabs and rollers used in grinding maize), stone remains were remarkably few, and represented by only three spear-blades of flaked chert Obsidian flakes and cores were found in quantities

A remarkable bone pendant was discovered in the second stratum. This is formed from the ascending ramus of the right mandible of a human lower jaw The condyles have been filed off, and just below the notch a hole has been pierced for suspension. The exterior surface is covered with relief carving, the main feature of which is four glyphs arranged in a square This object, which is probably an amulet, is, I believe, unique

Objects of worked shell are rare, and limited to a few beads The most interesting is a large spiral shell, which had been rubbed down on two sides, so that the remaining portion represents the central longitudinal section Small river shells, some pierced for suspension, were found in quantities

## New Sundial in the Royal Botanic Gardens, Kew.

SOME months ago a beautiful pillar which had come from the old Kew Bridge, and had been presented to the Royal Gardens by Mr George Hubbard, was set up in the grounds of Cambridge Cottage Prof. Vernon Boys, having learned from the Director that a sundial was required to stand on this pillar, generously offered to provide one which would be worthy of the position. Prof. Boys has designed a dial and made it himself. It is now in place and can be seen and proved by the public (Fig. 1).

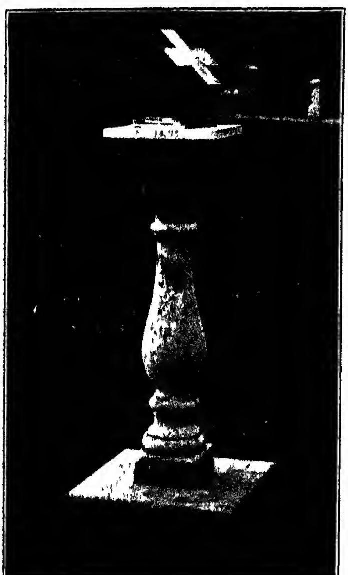

FIG 1—New sundial in the Royal Botanic Gardens, Kew.

Nowadays a sundial is generally regarded as a mere ornament to a garden, and if it is in error by a few minutes nobody minds After all, the dial gives local apparent time and it is too much trouble for most people to ascertain the correction necessary to obtain Greenwich mean time Prof. Boys has no patience with such slackness He has aimed at getting the time to the nearest minute Not only is his dial made with the greatest precision; it carries an inscription on the southern or upper cube which gives in clear figures the correction to be applied to deduce Greenwich mean time from Kew apparent time on any given day of the year. This is contained in a table of 88 entries calculated from the equation of time of next year (a year half-way between two leap years), for each day, to which the time corresponding to the longitude of Kew has been (algebraically) added. Any member of the public by adding the correction of the actual day to the time shown by the sun, or subtracting as the case may be, will have Greenwich mean time.

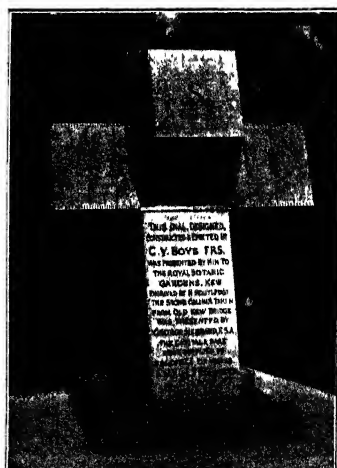


FIG 2—'Dial' of the Kew sundial

The dial itself is not of the conventional type (Fig 2) In fact it is doubtful whether the word 'dial' is strictly appropriate Perhaps we should say that there are six dials Prof Boys had adapted a design which is to be found occasionally in churchyards The dial is built up with five blocks arranged in the form of a Greek cross When the dial is in position the plane of the cross is parallel to the equator, so that the outer edges of the cubes which form the arms are parallel to the earth's axis The shadows of these outer edges fall in succession on the adjacent arms of the cross The graduations which serve for telling the time are along the edges Gun-metal has been used for the cross and its stand The central block is a cube; the other four blocks which form the arms of the cross are 3 in long and 2$\frac{3}{8}$ in wide The accurate machining of these blocks is a necessity of the design

The engraving was done for Prof Boys by Mr H. Routledge, who is the engraver responsible for the finest work on Admiralty charts. After the divisions and lettering had been engraved, each part of the dial was exposed to very dilute hydrogen sulphide and ammonia for about two minutes. The black was cleaned off the flat surfaces with Water-of-Ayr stone and the engraved work was left black The effect is very pleasing.

The five blocks which form the dial are mounted on a trapezium-shaped support at the inclination appropriate for Kew. How the parts are held together is not apparent. The support is attached to the stone pedestal in a neat way Four bolts are cemented into the pedestal. After the nuts were screwed on to these bolts, melted tin was poured into little pits surrounding the nuts and hides them from sight No one will be tempted to unscrew the bolts and appropriate the sundial

The precision with which a sundial can be used is limited by the lack of sharpness in the shadow of the gnomon Theoretically, the width of the penumbra should be equivalent to two minutes on the time scale It is found that time can be read to a minute on the new dial Probably the reading corresponds fairly closely with the middle of the penumbra and is therefore in accordance with the intention of the designer By a curious chance the sundial has been placed in the only part of the Royal Gardens from which a public clock is clearly visible The clock of Kew Church can be seen over the wall of the Gardens and it will be possible to regulate the clock by direct comparisons with the dial

It will be seen from Fig. 1 that the dial is well balanced on its pillar and looks handsome as well as businesslike

The history of the dial and the stone column which supports it is engraved on the sloping face of the trapezium-shaped support and is as follows

"This Dial, Designed, Constructed & Erected by C V. Boys, F R S, was presented by him to The Royal Botanic Gardens, Kew. Engraved by H Routledge. The Stone Column taken from Old Kew Bridge was presented by George Hubbard, F S A, the capital and base were supplied by H M Office of Works. A. W. Hill, F.R.S, Director 1929."

Visitors to the Gardens who are interested in sundials should remember to look at the dial which was put up by William IV to commemorate Bradley's observations at Kew House The pedestal of this sundial bears the King's monogram very skilfully carved. The dial itself was made by Tompion.

## Filterable Viruses.[1]

THE invisible multiplying bodies generally known as filterable viruses are among the most interesting things in biology to-day, partly because they are the cause of many diseases in animals and plants, and chiefly because they seem as if they might in the end prove to be some of the transitional forms between live and dead matter Knowledge about them is moving so quickly that it is difficult to know at any moment where we are, and the compilation which Dr. E B McKinley has put together will be welcomed as a useful attempt to summarise all we know of them up to date.

Dr. McKinley deals rather fully with the virus diseases of man, animals, fowls, fishes, and insects—about fifty in number—and has a chapter on typhus and the other *Rickettsia* diseases, in which the organisms are just visible. Under each disease he gives an adequate summary of the behaviour of the virus, and, going through them, one cannot but feel that we have to do with what is really a natural group of agencies, though they are distinguished from better known agencies, such as bacteria, mainly on the point of size.

These summaries necessarily contain only a selection of what has been said about each virus, and the selection of the compiler is naturally influenced by his point of view. Dr. McKinley writes mostly as a systematist and he nowhere notices Sanfelice's work on epithelioma contagiosum of fowls, his separation of a nuclo-proteid which would reproduce the disease on inoculation into a fresh animal and his fundamental suggestion that a virus might be a chemical substance which influenced cells in such a way that they produced more of it.

The account of the virus diseases of plants is far less satisfactory. it is not clear whether the author meant it to be as complete as that of the animal diseases or not. it certainly is not. This is rather unfortunate, for plants show clearly some important points which are not so plain in animals, as, for example, the possibility of a host containing large quantities of virus without showing any symptoms of disease, as potatoes often do The modes of transmission in the plant diseases are also curious, for while some of them, for example, tomato mosaic, are easily conveyed by contact or inoculation, others, such as aster yellows, can be passed from one plant to another only by insects and artificial inoculation fails. The animal diseases such as yellow fever, which are normally conveyed by insects, can be transmitted equally well by a hypodermic syringe. It seems as likely that we shall get a just view of what viruses really are from a study of those of plants as from those which affect animals: the Rous cancer virus and the bacteriophage are also very significant: both of them are dealt with by McKinley.

Another section discusses the vexed question of invisible forms of ordinary bacteria, for which there is a good deal of evidence not to be lightly dismissed, and finally the strange 'inclusion bodies' are described and abundantly illustrated. These large intracellular, often intranuclear, objects are present in many, though not all, of the animal and plant diseases, and they have a characteristic appearance which may be put to useful purposes in diagnosis, for example in rabies. They may represent some form or stage of the virus itself, but they are more probably peculiar cell-reactions: their specificity recalls that of plant-galls, and contrasts strongly with the relative uniformity of the tissue reactions of animals to different bacillary parasites.

[1] "Filterable Viruses and Rickettsia Diseases." By E B. McKinley. *Philippine Journal of Science*, vol. 39, pp 1-416, 70 plates; 1929.

## Radio Communication in the British Navy.

THE history of the development of radio communication in the British Navy is of great interest From a paper on "Naval Wireless Telegraph Communications", by G Shearing and Captain Dorling, which was read to the Institution of Electrical Engineers on Dec 4, we learn that Admiral Jackson experimented with radio waves so far back as 1896 In 1899, with the help of Marchese Marconi, ranges up to 50 miles were obtained In 1909 a crystal detector was first used, and in 1914, immediately prior to the War, valve reception was passing out of the experimental stage During the War, arc and spark systems were generally used, but the thermionic valve system soon made them obsolete The six months' cruise of H M S *Renown* in 1927 provided opportunities for testing the capabilities of short wave working on long ranges With the exception of three days, communication was easily maintained with Whitehall.

The British Navy is divided up into squadrons, which are normally situated in distant seas under the orders of a Commander-in-Chief There are squadrons, for example, in China, the East Indies, Africa, America, and the West Indies Each naval area has one or more land radio stations which act as terminal points for the traffic to and from the Admiralty and as distributing and collecting centres for ships in the vicinity. If no commercial stations are available the naval stations are also used for communicating with merchantmen. They have a range varying from 1000 to 2000 miles and can also be linked up with the cable and land-line systems The advent of the short-wave system has now made it possible for ships in any part of the world to communicate directly with each other and with the Admiralty at certain times of the day

To obtain the results given above, H M ships of the cruiser class are fitted with a 12 kilowatt transmitter for long waves and an 8-kilowatt transmitter for short waves. Valve transmitters are always used The long wave apparatus has a range of about 1500 miles In addition, they have two or three sets of receiving apparatus for long and short waves, besides direction finding sets and fire control radio sets. All the standard apparatus used is robust and simple to handle It is proof against vibration and shocks from gunfire and has to be trustworthy under all climatic conditions In the battle fleet, the commander must be able to transmit his orders to any unit of the force and be in touch with the Admiralty at the same time

The striking feature of a modern fleet action is the speed at which everything happens If the two fleets are approaching one another at a speed of between 40 and 50 miles an hour, then even with aircraft reconnaissance the time between first sighting the enemy and joining action may be only about an hour. The valve transmitters used after the War generally used frequencies between 60 and 3000 kilocycles, that is, wave-lengths between 5000 metres and 100 metres. The introduction of short waves, however, has modified the requirements very considerably. Their advantages for long range working at distances from a few hundred miles up to world-wide range during certain hours of the day are well known. It has been necessary, therefore, to arrange for the fitting of attachments to the existing sets capable of transmitting on a band of waves from 4300 to 21,500 kilocycles in breadth (wave-lengths of 70 metres to 14 metres)

## Antarctic Meteorology.

AFTER considerable delay, due principally to lack of funds, it was found possible in 1923 to undertake the tabulation and reduction of the several series of meteorological observations taken by the Australasian Antarctic Expedition of 1911–14. The first two (Series B, Vols. 3 and 4) of four contemplated volumes are now published[1] Another volume is to deal with the records taken during a winter at Queen Mary Land and the observations made on the aurora during the antarctic and sub-antarctic courses, and the last will contain a discussion of the figures.

The Macquarie Island station functioned after the return of Sir Douglas Mawson's Expedition, but owing to War conditions was closed down in December 1915. It has not since been found possible to reopen it. The monotony of the climate does not suggest that very important data would be obtained from its continuance, however valuable it might be in forecasting. Temperature ranged within a few degrees of 40° F.; precipitation occurs on most days in the year and strong westerly or north-westerly winds prevail. The rainfall records are not so complete as the other data, which are very full.

Vol. 4 covers a period of 22½ months at Cape Denison on Commonwealth Bay, the headquarters of the expedition. These data are most important in their contribution to the study of the antarctic climate and particularly to the well-known antarctic blizzards. Sir Douglas Mawson chose a thoroughly uncomfortable but most valuable site for his station He arranged for all observations to be taken every six hours, except during the latter part of the second year, when the screen thermometer was read only once a day. In addition to the detailed tables, the meteorological journal of the expedition is printed

Mr. Madigan rightly says that the wind is the outstanding characteristic of Adélie Land So far as records go, Commonwealth Bay would appear to be the windiest place on earth. The mean hourly wind velocity for the whole period of 22 months was 44·2 miles per hour It may be recalled that 43 miles per hour is a gale on the Beaufort scale. In February 1912, which was the calmest month, the average velocity was 26·2 miles per hour. Wind velocities were taken with a Robinson cup anemometer, except for short periods when they were visual owing to the instrument being damaged by the wind.

The wind blew mainly from the south-south-east and south and was generally very steady, so that after some practice the explorers abandoned crawling and walked on their feet in 90-mile currents of air, leaning on the wind. There were occasional periods of calm and variable winds, but these were apparently local, for the wind could frequently be heard roaring on the plateau to the south, and to the west of the station drift snow could be seen sweeping down to the sea. Local whirlwinds from the north sometimes interrupted the short calms.

Mr. Madigan does not discuss the antarctic atmosphere circulation, but we hope he will do so in the final volume of the series.

[1] Australasian Antarctic Expedition, 1911–14 Scientific Reports. Series B, Vol 3: Meteorology Tabulated and Reduced Records of the Macquarie Island Station Recorders G. F Ainsworth, H Power and A C Tulloch. Reduction and Tabulation of Data, by Direction of H. A Hunt, and under Superintendence of B W. Newman Pp 544+4 plates 40*s* Vol. 4. Meteorology. Tabulated and Reduced Records of the Cape Denison Station, Adélie Land. By C. T Madigan, with an Appendix by W E Bassett. Pp 286+viii+2 plates 30*s* (Sydney. Alfred James Kent, 1929.)

## University and Educational Intelligence.

BIRMINGHAM.—At a degree congregation held on Dec. 13, the degree of M.D. was conferred on John William Field for a thesis entitled, "A Study of the Dietary of the Tamil Cooly of the British Malaya, with special reference to the influence of Vitamin A, Starvation of Physique, and Resistance to Disease"; and on Cyril John Polson for a thesis on "Observations upon the Metabolism of Iron in the Animal Body" The degree of D.Sc has been awarded to Francis Eric Keep for a thesis on 'The Geology of the Shabani Mineral Belt, Belingwe District", and other reports of the Southern Rhodesia Geological Survey

BRISTOL.—On Dec 13, Mr Winston Churchill was installed as Chancellor of the University After the ceremony, the honorary degree of LL.D. was conferred, among others, on Mr Churchill and on Dr T. F. Sibly, vice chancellor of the University of Reading

CAMBRIDGE.—A meeting of the electors to the Drapers professorship of agriculture will be held on Friday, Jan 17. It is proposed that the stipend of the professor shall be £1200 a year in addition to £200 as head of the Department. The administrative duties of the professor include co operation with the Ministry of Agriculture and Fisheries, which gives financial support to the School of Agriculture and maintains a number of agricultural research institutes closely associated with it Candidates should communicate with the Vice Chancellor on or before Tuesday, Jan. 7.

The Director of the Solar Physics Observatory has appointed Mr. C P. Butler to be first senior observer and Mr W Moss to be second senior observer

Mr W B. R. King, Magdalene, has been reappointed assistant to the Woodwardian professor of geology.

Mr. L C. G Clarke, curator of the Museum of Archæology and Ethnology, has been elected to a non-stipendiary fellowship at Trinity Hall.

GLASGOW.—The chair of geology in the University, recently vacated by Prof J. W Gregory, has now been filled by the appointment of Mr E B Bailey, of H.M Geological Survey Prof. Bailey is one of the most distinguished of Scottish geologists. He has played an important part in the work of the Geological Survey during recent years and is particularly well known for his studies on Carboniferous igneous rocks and his unravelling of the complicated geological structure of certain parts of the Western Highlands—notably the Island of Mull and the Ben Nevis–Glencoe district. In the period of the War, Prof. Bailey also played his part, and was awarded the Military Cross, the Légion d'Honneur, and the Croix de Guerre with Palm.

ACCORDING to the twelfth report of the Technical Optics Committee of the Imperial College of Science and Technology and the Advisory Council in Technical Optics to the London County Council, for the year ending July 31, 1929, the teaching at the Imperial College and at the Northampton Polytechnic has be co-ordinated by the adoption of the same symbols, and it is proposed to provide at the latter a two-year day course in addition to the one-year course provided hitherto. At the Imperial College ultra-violet microscopy is to be developed for regular users of the microscope and research work on colour vision, resolving powers of objectives, and the ruling of gratings is to be continued. Prof. A. O. Rankine has been appointed Director of the Department. The number of students is about 20, and the annual cost about £5000.

## Calendar of Patent Records.

**December 22, 1818**—The hobby-horse, the forerunner of the bicycle, was the invention of Baron von Drais, and was introduced into England by Denis Johnson, coachbuilder, of Long Acre, who was granted a patent for it on Dec 22, 1818, under the title of a machine for the purpose of diminishing the labour and fatigue of persons in walking and enabling them at the same time to use greater speed, which said machine he intends calling 'the pedestrian curricle'". One of his machines, built for a Duke of Marlborough, is now in the Science Museum

**December 23, 1801**—The jacquard loom takes its name from Joseph Marie Jacquard of Lyons, who was granted a patent in France on Dec 23, 1801, "pour une machine destinée à suppléer le tireur de lacs dans la fabrication des étoffes brochées et façonnées" The specification states that the inventor first made a machine of the type in 1790 and that at the date of the patent more than four thousand were in use in the neighbourhood of Lyons

**December 23, 1834.**—The hansom cab is named after Joseph Hansom, whose first patent was granted on Dec 23, 1834 The original cab was in the form of a sedan chair slung between large wheels with the driver's seat on the roof in front and a door at the back, the well-known construction being introduced with a second patent two years later granted to Gillett and Chapman, to whom the first had been assigned A company was formed and started with 50 cabs, but was forced to compete with many imitators, in spite of several favourable verdicts in the courts

**December 24, 1836.**—The name of Bennet Woodcroft will always be associated with the great reform of British patent law and practice that was brought about by the Amendment Act of 1852. Upon the passing of the Act, Woodcroft was appointed to the post of superintendent of specifications in the new department, and it was mainly through his enthusiasm and exertions that so many needs of the inventor were quickly met by a liberal interpretation of the new Act. To him is due the printing and indexing of the patent specifications, and he was also primarily responsible for the institution of the Patent Office Library and of the Science Museum. Before his association with the office, Woodcroft was a prolific inventor. One of his patents, dated Dec. 24, 1836, was for a process of printing calico with indigo, in which, to avoid the rapid oxidation which takes place, the operations were carried out in an atmosphere of coal gas.

**December 24, 1866.**—An early self-excited dynamo was that for which a British patent was applied for by Cornelius and Samuel Varley on Dec. 24, 1866. Two electro-magnets of horse-shoe form and two bobbins mounted on an axis are so arranged that when the bobbins are rotated they act simultaneously between the poles of the two magnets, a commutator serving to join up the whole into one continuous circuit The residual magnetism is used to start the action. The application was not completed, but a patent was granted for the same invention on a second application made six months later.

**December 24, 1877.**—Edison's first United States patent for the phonograph was applied for on Dec. 24, 1877. The machine had a metal drum provided throughout its length with a fine spiral thread, over which a sheet of tin-foil was tightly pressed. A needle attached to a mica diaphragm rested on the tin-foil and recorded the sounds thereon. The specification describes the use of a clockwork motor, but the original machine made by Edison, which for some time was on loan to the Science Museum, South Kensington, was operated by hand

## Societies and Academies.

### LONDON.

**Society of Public Analysts**, Dec 4.—**A. P Laurie**. The methods of examining pictures An outline was given of the composition of the different pigments used for old illuminated MSS and oil paintings, and methods of sampling by means of a micro borer and examination by means of a microscope polariscope were described, a summary of micro chemical tests for the various classes of pigments was given The use of X-ray photography and ultra-violet rays was discussed, and it was shown how an examination of the brush strokes in an oil painting, considered in conjunction with the chemical and optical properties of the pigments, enabled a judgment to be formed as to whether the whole work had been produced in one studio and at the same period.—**S Glasstone** and **J C. Speakman**. The quantitative analysis of mixtures of nickel and cobalt Electrometric titrations of nickel and cobalt solutions with potassium cyanide, with nickel and cobalt indicator-electrodes, respectively, have established the soundness of the theoretical basis of the Rupp and Pfennig method of determining these metals. A modified iodimetric method has also been developed for determining small amounts of cobalt in the presence of nickel.—**J. C. Baird** and **J H. Prentice** The changes with age of the hydrogen ion concentration of egg white and egg yolk. Determinations of hydrogen ion concentration by means of a quinhydrone electrode indicated that the normal *p*H value of fresh egg white is approximately 8·6, and that there is a rapid rise in the course of the first week of storage to a level of about *p*H 9 0, at which figure the reaction remains fairly constant. The fresh yolk has a reaction of approximately *p*H 6 0, which in the course of ten weeks rises to about 6 2 The refractive index of the egg white is constant at about 1 360.

### PARIS.

**Academy of Sciences**, Nov. 12—**Pierre Weiss, R. Forrer, and F. Birch**. The magnetisation to saturation of the nickel-cobalt alloys and the atomic moments of nickel and cobalt—**de Sparre**: The necessity of taking into account the contraction on setting in the calculation of the work in armoured concrete.—**N. Lusin** and **W. Sierpinski** The classes of the constituents of an analytical complementary.—**Georges Bouligand**: The successive fronts of an ensemble of points—**A. Magnan** and **A. Sainte-Lague**. New experiments on the resistance to the progress of fish in water. The experiments were carried out on 22 species of dead fish loaded so as to fall in water under the action of gravity: the motion was followed with a kinematograph. For most fishes the resistance was found to be constant, but with one, the ray, the resistance increased with the velocity.—**René Audubert**. The influence of the nature of the electrolyte on the potential of inversion of the photovoltaic effect.—**Mme. Ramart-Lucas**: The comparative stability of isomers according to their absorption spectra. The relation between the absorption in the ultra-violet and structure of the diaryl derivatives of ethylene and ethane. The ultra-violet absorption curves differentiate the structures of isomers with more certainty than any other physical property.—**G. Baeckeroot**: The presence of fossils of Aquitanian age in the scattered quartzite grits at the surface of the Moselle plateau.—**F. Labrousse** and **J. Sarejanni**: Changes of reaction and phenomena of oxido-reduction observed in the course of the development of some fungi. The increasing alkalinity of the culture medium shown by certain fungi is not due to the formation of ammonia. As regards the reducing power, all the fungi studied except one (*Thielavia basicola*) decolorise cresyl blue.—**Sébastien Sabetay**. The presence of β-ionone in a natural product Commercial essential oil of *Boronia megastigma* contains a good proportion of β-ionone.—**A. Babes**: The thymus and growth.

### CRACOW.

**Polish Academy of Science and Letters**, Oct 7—**Lad Natanson**. The theorem of the Eiconnel and Fermat's principle—**K Kordylewski** The variable star YY Sagittarii. The elements are calculated from 436 observations taken during 1925–29—**J. Pagaczewski** The variable star 259.1928 Cassiopeæ. The provisional elements calculated from 118 observations on 32 nights during 1928–29.—**J. Mergentaler**: The variable star XX Cephei The provisional elements deduced from 147 observations during 1929.—**Wlad. Gorczynski** The high values and energy losses of the solar radiation observed in desert regions and on tropical mountains—**L Chrobak**: Contribution to the technique of the X-ray examination of easily deformable crystals—**Mlle. A. Dorabialska**: The application of the adiabatic microcalorimeter to measurements of the quantities of heat emitted by uranium, thorium, and radioactive minerals The instrument used was capable of measuring thermal effects of the order of $10^{-4}$ to $10^{-5}$ calories per hour, and was applied to measuring the radiation of $U_3O_8$, $ThO_2$, and pitchblende.—**K. Dziewonski** and **T. Waszkowski**: Researches on α-methylnaphthalene—**Mme. T. Cyge**: Anatomical and ecological studies on the leaves of indigenous orchids—**K. Mielczarek** and **W. Brykalski**: The pollen analysis of Iwiec peat bog—**Mlle. I. Toruwska** Studies on the life of the iron bacteria.—**L. Ejsmont**: The two genera of Schistosomatides of birds.—**Z. Szantroch**: The histogenesis of the nerve ganglia of the heart.—**B. Dybowski**. Contribution to our knowledge of the Siberian seal.—**B. Dybowski**: The Polychætes of Lake Baikal.

### LENINGRAD.

**Academy of Sciences** (*Comptes rendus*, No. 17).—**D Beliankin**. Chemical degeneration of dinas. Analyses of a dinas brick subjected more than 600 times to the action of a furnace showed a considerable increase in $Fe_2O_3$, $Fe_2O_5$, and MnO, apparently received from the gases in the furnace.—**L. Lozina-Lozinskij** The phenomena of chemotaxis in connexion with the choice of food by infusoria. The chemotactic reactions and the reactions of ingesting food particles have apparently a common physiological basis. Chemical properties of the substance used in the experiment have the same effect on the reactions of locomotion, digestion, and even of division, namely, either increasing or decreasing the rate of all these functions—**A Tsvetkov**: Changes in the coloration of apatites submitted to heating If apatites are heated to 1700° C., regular changes in colour are observed, there being a definite colour corresponding to each stage of temperature. This is an unreversible process.—**S. F. Tsarevskij**: Contribution to the classification and distribution of the lizards of the genus *Phrynocephalus*. A study of the cranial characters permitted the author to evaluate them from the point of view of systematics, which so far have been based on external features only. *Ph. ludovici* Mocq. is regarded as identical with *Ph. axillaris*, and *Ph. erythrurus* Zugm. identical with *Ph. lidskii* Berd—**J. Argentinovskij**: A new cinnabar ore deposit in the Urals The new deposit has been discovered 118 km. north-west of Sverdlovsk (Ekaterinburg). The veins of the ore are included in quartz porphyrite. This is the third known deposit of cinnabar in the Ural mountains

ROME

Royal National Academy of the Lincei Communications received during the vacation.—A. Angeli and Z. Jolles Reduction of normal diazo hydrates The formation of hydrocarbons from the corresponding normal diazo-hydrates by the action of weak reducing agents indicates that an unstable compound, such as phenyldi-imide, is formed as an intermediate step in the change. That this is actually the case is shown by the formation of s benzoylphenylhydrazine when the reduction is effected in presence of benzaldehyde. Various other reactions are explainable similarly. The transformation of the normal diazo-hydrate into the compound $C_6H_5$ . N NH by reduction renders it probable that the hydrate has the structure, NH · NO $C_6H_5$. It is possible to remove, not only the oxygen atom, but also, by the action of nitroxyl, the imine residue from the diazo-hydrate.—D. Th. Egoroff · *W* congruences with regulated focals.—M. Kourensky: The method of integration of the equation to the partial derivatives of the second order with a single unknown function and two independent variables.—A. M. Bedarida: The theory of ideals of a finite algebraic body (3).—B. Colombo. Bianchi's problem regarding Lamé families.—B. de Finetti: Functions with aleatory increment.—E. Raimondi: A new phenomenon of aerodynamics.—C. Cannata · The ballistic hypothesis and the verification of the law of areas in the orbits of telescopic double stars. Any possibility of verifying the ballistic principle on the basis of observations on telescopic doublets is out of the question.—M. Tenani: Theoretical-experimental considerations on the course of the tides in the Adriatic (2). Experimental verification has been attained, in the case of the Adriatic Sea, of deductions previously drawn from theoretical considerations This result, together with the calculation, of considerable practical importance, of the longitudinal displacements of the water during the day through the Straits of Otranto, confirms the possibility of extending analogous considerations and calculations to other seas.—B. Rossi and G Bernardini The photographic action of low-speed electrons. Using oiled Eastman plates, Kenneth Cole and other observers have found that low-speed electrons with velocity lower than that corresponding with 25 volts have no detectable effect on the photographic plate By means of a special arrangement, the authors are able to photograph electrons with velocity 17 5 volts with ultra sensitive Cappelli plates. Since the energy possessed by these electrons still greatly exceeds that necessary to affect a silver bromide granule, it is not improbable that this limiting voltage is capable of further reduction.—F. de Carli · Viscosity isotherms of binary mixtures (3): the system nitrobenzene-stannic chloride. Thermal analysis of this system confirms the formation of only one complex compound, $C_6H_5NO_2$, $SnCl_4$, melting at about $-11°$ C. The density isotherm for 15° reveals a sensible increase in volume, which denotes a dissociating action, probably due to the nitrobenzene. The viscosity isotherms for 15° and 25° exhibit distinct maxima, but the greatest divergences from the calculated values are shown by solutions containing about 50 per cent of nitrobenzene, whereas the compound formed contains 31·18 per cent. Thus, the maximum of viscosity is displaced towards the more viscous component, a phenomenon which is manifested by liquids in which the complex is highly dissociated. It may be, however, that molecules of the composition $2C_6H_5NO_2$, $SnCl_4$ exist in a stable form in the liquid state but decompose on solidification.—G. Charrier: Condensation of 1-amino-2-phenylazonaphthalene-4-sulphonic acid Dehydrogenation of this acid, suspended in nitrobenzene, by means of an acetic acid solution of chromic anhydride, yields a sulphur containing condensation product exhibiting the characters of a polycondensed ditriazole derivative To this is attributed provisionally a constitution analogous to that of naphthylene dioxide, from which it may be theoretically derived by replacing the two oxgyen atoms by two $SO_2$ groups and attaching the 2-*N*-phenylated triazole nuclei, in the 1- and 3-positions of the triazole nucleus, in the 1- and 2-positions of the two naphthyls.—E Pace Organo-aromatic derivatives of boron Descriptions are given of the methods of preparation and properties of borophenyl chloride, $C_6H_5BCl_2$, phenylborine or boroaniline, $C_6H_5BH_2$, which readily oxidises in the air, giving monophenylboric acid, and borobenzene, $C_6H_5$ B B . $C_6H_5$, which decomposes in the air to form a pasty mass, probably borooxybenzene.—G. Sani. The reducing activity of roots of the Gramineæ (3). reduction of calcium nitrate. The reduction of calcium nitrate by maize roots is inhibited by the presence of small proportions of potassium hydroxide, chloroform, or formaldehyde, and also by heat or desiccation. In small quantity citric acid enhances the effect, but sulphurous acid is without influence. During the reduction the reaction of the medium changes from acid to alkaline, the alkaline product or products probably being the active agent in arresting the change.—M. Anelli: Covering phenomena in the Emilian Appenines.—R. Savelli and N. Soster Sudden variations in the leaf form of *Cannabis sativa* L. Hemp exhibits two distinct variations of leaf shape, characterised by the replacement of the normal palmate type by a single margin, one being pinnatifid (lobed) and the other entire (simple leaf) The former represents a stable mutation, recessive with respect to normal, whereas the second must be regarded as a non-fixable sport, which affects whole plants or parts of plants and arises as a reaction to abnormal stimuli, with no necessary relationship to the pinnatifid form.—Giulio Cotronei and Aldo Spirito: Zoological constitution and grafting (1) · Experiments with Anura and Urodela.—Aldo Spirito: Processes of regeneration and of regulation in the encephalic region of the embryos of Urodela (3). With *Triton cristatus*, at the stage of primary optical vesicle not yet introflexed, it is possible, by means of a technique outlined, to realise the regeneration of a more or less marked, entire prosencephalic wall Such regeneration is followed by regulation phenomena which induce the formation of parts comparable with cerebral hemispheres, but neither with Anura nor with Urodela do the dimensions of the regenerated parts reach those of the corresponding normal parts.—P. Pasquini and A. della Monica. Regeneration of the crystalline in the larvæ of Anura. The faculty of regeneration possessed in the eye of Urodela, by the cells of the iris for developing a crystalline, is extended to Anura (*Rana* and *Bufo*), in the eye of which analogous phenomena are exhibited as a result of the removal of the normal crystalline: mainly the proliferation and consequent spreading of the leaflets of the iris, which lead to the metaplastic formation of a new lens. The latter is at first continuous with the iris, usually with the upper edge, but exceptionally also with the lower edge, but later becomes independent.—M. Curzi: A pseudo-rotting of the caryopsis of wheat. A sample of Arditi wheat, which had undergone auto-heating in the ear after reaping, was found to be attacked by *Acremoniella thermophila* n. sp., which is capable of developing between 30° and 52° C.

### SYDNEY.

**Linnean Society of New South Wales, Oct 30.**—**A Jefferis Turner** Revision of Australian Oenochromidæ (Lepidoptera) (1) The Oenochromidæ display considerable variation in structure and, being the most primitive Geometrites, they throw much light on the phylogeny, not only of the group as a whole, but also of the constituent families In this first part of the revision, sixty-four species belonging to ten genera are dealt with, two genera and ten species being described as new.—**Rev H M. R Rupp** Variations in certain orchids. Attention is directed to frequent variations of *Dendrobium speciosum* Sm, and a form approaching *D gracilicaule* F v M is described as a new variety Points of distinction are given between the northern form of *Prasophyllum intricatum* Stuart, and the typical form of the southern States. A red flowering form of *Pterostylis ophioglossa* R Br., confined to high gullies in stony hills, is described as a new variety—**Frederick H. S Roberts** A list of the Australian Bombyliidæ of the subfamilies Exoprosopinæ, Anthracinæ, and Bombyliinæ in the German Entomological Museum, Berlin The subfamily Exoprosopinæ is represented by the genera *Hyperalonia* Rond (7 species), *Exoprosopa* Macq. (1 species), *Villa* Lioy (4 species), and *Pseudopenthes* Roberts (the genotype). The genus *Anthrax* of the Anthracinæ is included, two species being represented. Of the Bombyliinæ, *Bombylius* Linn has two species, *Systoechus* Loew two species, and *Sisyromyia* White two damaged specimens —**A M Lea**: Descriptions of new species of Australian Coleoptera (20). Forty-seven new species of the families Mordellidæ and Curculionidæ —**J. R. Malloch**: Notes on Australian Diptera (22) Notes on members of the genera *Celetor*, *Dasyortalis*, *Duomyia*, *Euprosopia*, *Pterogenia*, *Naupoda* and *Lamprogaster* of the family Ortalidæ. A new subgenus of *Duomyia* and a new species of *Lamprogaster* are described.

### VIENNA.

**Academy of Sciences, Oct. 17.**—**F. Heritsch**: The tectonic position of the Hochwipfel- and Nassfeld-facies in the carboniferous of the Carnic Alps.—**A. Stock and W. Zimmermann**: The vapour pressure of mercury at low temperatures.—**F. Hernler**: The three isomeric nitro- and amino-phenyl-1-dimethyl-3, 5-triazoles-1, 2, 4, and some of their salts.—**L. Kober.** Structural elements of the east and south Carpathians.—**F. Blank and F. Urbach**. Sols in crystals. To elucidate the formation of crystal-sols the solubility of gold in molten alkali halides was explored.—**O. Abel**: Explanation of the crawling tracks in the sandstone of Greifenstein near Kierling in the Wienerwald. Observations on the seashore of the South African coast in Algoa Bay near Port Elizabeth and in False Bay near Muizenberg in August and September of this year have led to complete explanations. The ebb-tide leaves a fine hard sand on which *Bullia* snail-shells leave their tracks.—**A. Thiel**: Sensitiveness and resistance to alkalis in phthaleins and sulphophthaleins.—**H. v. Euler and B. Jansson**: Catalytic hydrogen peroxide decompositions by metallic compounds.—**G. Bredig, S. R. Carter, and M Enderli**: The equilibrium of carbon dioxide evolution from formic acid and its potential.—**C. Neuberg and Max Scheuer**: Detection and isolation of methyl-glyoxal formed biochemically as dioxime.—**E. Berl and H. H. Saenger**. The system $N_2O_5$-$HNO_3$

**Oct. 24.**—**H. V. Graber**: Geological and petrographical researches on the Upper Austrian and Bavarian primitive rocks.—**H. V. Graber**: Mixed rocks from the Upper Austrian and Bavarian primitive rocks—**A Dadieu and K W F Kohlrausch**: Studies on the Raman effect (5) The Raman spectrum of organic substances, C O and C=C double-linkages, halogen derivatives. 27 substances were examined An attempt was made to connect frequency with molecular structure—**S Loewe and H E Voss** Preparation, properties, and testing of a male sexual hormone A search for a male counterpart of the female thelykinin The active substance is possibly soluble in water and weak acids as a colloid, freely soluble in alcohol, ether, and oil Stable in aqueous solution for twenty-four hours, in organic solvents for at least some weeks. Not species-specific, preparations from testicles of ox and guinea-pig acting on mouse like mouse-products The aqueous preparations lead to fatal general poisoning. The publication made now is a transcript of a communication deposited until seal in 1927, but now announced because others are publishing the effects of testis extract injection—**R Singer** Progress and result of a botanical expedition to the Caucasus in 1929 The south west region was explored Gultschj, Kunjum, Scharwzek, Zuzchurtu, Taurari. The primitive forest finds its limit at 2000-2400 metres A provincial museum at Sugdidi and a botanical garden near Batum proved helpful—**A. Steinbock**. Hydrobiological work in the Tyrol alps. Alpine lakes were explored at and above 2000 metres. The fauna included Turbellaria and trout—**M Beier** Results of a zoological expedition to the Ionian Islands and the Peloponnesus (1) and (2).

**Oct 31.**—**M. Beier and F. Silvestri**. Results of a zoological expedition to the Ionian Islands and the Peloponnesus (3) Thysanura—**R Kloimwieder**: The tubular cells of Fumariaceæ, especially those of the genus *Dicentra*. These cells contain poisonous alkaloids The plants seldom suffer from grazing or from fungus parasites Feeding experiments on snails gave confirmatory results—**M. Blau and E. Rona**: Communication of the Radium Institute (241) Further contributions to ionisation by H-particles.—**K. Zentner**: The efficiency of sand-blasts.

## Official Publications Received.

### BRITISH.

Ceylon Journal of Science Section D Medical Science Vol 2, Part 3 The Identification of the Land Snakes of Ceylon By Dr Lucius Nicholls Pp 91 157 (Colombo Bacteriological Institute, London Dulau and Co, Ltd) 3 rupees.

Air Ministry Aeronautical Research Committee. Reports and Memoranda. No 1199 (Ae 360) Skin Friction and the Drag of Streamline Bodies By Prof. B M Jones (T 2709 and (a) and (b).) Pp 12+8 plates. (London H.M Stationery Office) 9*d* net

Modern Mining Explosives. Presidential Address delivered October 17th, 1929, by Dr William Cullen. Pp 36 (London. The Institution of Mining and Metallurgy)

Proceedings of the South London Entomological and Natural History Society, 1928-29 Pp. xx+98+13+8 plates (London.) 10*s*. 6*d*.

Sale of Food and Drugs Acts Extracts from the Annual Report of the Ministry of Health for 1928-1929 and Abstract of Reports of Public Analysts for the Year 1928. Pp. 15. (London: H.M Stationery Office.) 1*s*. 6*d* net.

Society of Chemical Industry: Chemical Engineering Group Proceedings, Vol 10, 1928. Pp 132 (London.) 10*s* 6*d*

London School of Hygiene and Tropical Medicine Report on the Work of the School for the Year ended July 31st, 1929 Pp. 36. (London)

British Photographic Research Association Report for the Year 1928-29. Pp. 15 (London)

International Federation of University Women Bulletin No. 11: Report of the Fifth Conference, Geneva, August 7 to August 14, 1929. Pp 155 (London)

Man and his World in the Light of Emergent Evolution. a Synopsis of the Course of Lectures delivered by Members of the University of St Andrews under the Adult Education Scheme for Fife and Stirlingshire in 1929-1930 Pp ii+57 (St Andrews.)

Canada. Department of Mines. Mines Branch Investigations in Ceramics and Road Materials (Testing and Research Laboratories) 1927. (No 697) Pp ii+80. (Ottawa. F. A. Acland.)

Journal of the Chemical Society. November. Pp iv+2425 2661+xii. (London)

Transactions of the Institute of Marine Engineers, Incorporated. Session 1929. Vol 41, November Pp. 687 781. (London)

Journal of the Indian Institute of Science Vol 12A, Part 14 Studies in the Proteins of Indian Foodstuffs Part 2 The Proteins of the Pigeon Pea (*Cajanus indicus*) By P S Sundaram, Roland V. Norris and V Subrahmanyan. Pp 193 205 (Bangalore ) 12 annas

Proceedings of the Royal Irish Academy Vol 39, Section A, Nos 1, 2 The Variation of Curvatures in the Deformation of a Curve in Riemannian Space, by A J McConnell, The Displacement or Deviation of Circles in Riemannian Space, by J L Synge Pp 20 1s Vol 39, Section B, Nos 3, 4, 5 The Action of Alcoholic Hydrochloric Acid on certain Unsaturated Ketones, by Brian Coffey and Dr Hugh Ryan, The Constitution of Iso catechin Tetramethyl Ether, by James J Drumm, Robert J P Carolan and Dr Hugh Ryan, On 3 4 Dimethoxylbenzyl 3 5 Dimethoxycoumaranone, by James J Drumm, Sheila M Maguire and Dr Hugh Ryan Pp 107 123 1s Vol 39, Section B, Nos 6, 7, 8 Preparation and Oxidation of Flavindogenides, by Dr Hugh Ryan and George Cruess Callaghan, Some Derivatives of γ Anisylidene Methylethylketone, by Dr Hugh Ryan, Peter M'Geown and Dr John Keane, The Condensation of Aldehydes with Benzyl Acetoacetic Ester, by Dr Hugh Ryan, W B Cornelia and Pierse Hurley Pp 124 145 1s Vol 39, Section B, Nos 9, 10 Some Effects of Röntgen Rays on Seedlings, by Dr Sylvia B Wigoder and Ruth Patten, Further Study on the Effect of Summer and Winter Temperatures on the Catalase of Pine Needles, a Reply to Criticism, by F C Green, M E M'Endurfer, O S Orth and W E Burge Pp 146 159+plates 3 4 1s (Dublin Hodges, Figgis and Co, London Williams and Norgate, Ltd )

Department of Agriculture, Ceylon Bulletin No 85 The Termite proof Construction of Buildings in Ceylon By F P Jepson Pp ii+ 30+26 plates (Peradeniya ) 40 cents.

Report on the Administration of the Meteorological Department of the Government of India in 1928-29 Pp 19+4 plates (Calcutta Government of India Central Publication Branch ) 14 annas, 1s 6d

Royal Agricultural Society of England Agricultural Research in 1928 Pp viii+193. (London John Murray ) 1s

Report on the Conditions of Science Teaching in Oxfordshire Compiled by a Committee of the Oxfordshire Branch of the Incorporated Association of Assistant Masters in Secondary Schools Pp 8 (Oxford )

Royal Agricultural Society of England Report of the Council to the Annual General Meeting of Governors and Members of the Society, to be held at the Royal Agricultural Hall, Islington, London, N, on Wednesday, December 11, 1929, at 2 15 p m Pp 26 (London )

Harper Adams Agricultural College, Newport, Salop, 1929-30 Pp 96 (Newport, Shropshire )

The National Institute of Poultry Husbandry (Harper Adams Agricultural College), Newport, Salop A Progress Report of Instructional and Experimental Work in Poultry and Rabbit Husbandry No 2, August Pp 72 (Newport, Shropshire.)

Proceedings of the Royal Society Series A, Vol 126, No A800, December 2 Pp 183 (London Harrison and Sons, Ltd ) 6s

Proceedings of the University of Durham Philosophical Society Vol 8, Part 2, 1928-1929 Pp 71 159 (Durham ) 5s

Government of India Meteorological Department Magnetic, Meteorological and Seismographic Observations made at the Government Observatories, Bombay and Alibag, in the Year 1924, under the direction of Dr S K Banerji Pp x+133+5 plates (Calcutta Government of India Central Publication Branch ) 6 10 rupees, 11s

FOREIGN

Ministerio da Agricultura Industria e Commercio Directoria de Meteorologia Boletim Meteorologico, Anno 1923 Pp viii + 218 Boletim Meteorologico, Anno 1924 Pp viii+224 (Rio de Janeiro )

Methods and Problems of Medical Education (Fifteenth Series ) Pp iv+76 (New York The Rockefeller Foundation )

Department of the Interior Bureau of Education Bulletin, 1929, No. 14 Statistics of Teachers Colleges and Normal Schools, 1927-1928 Prepared by Frank M. Phillips Pp 71 10 cents Bulletin, 1929, No 27 Review of Educational Legislation, 1926-1928 By Ward W Keesecker Pp 20 5 cents (Washington, D C Government Printing Office )

Proceedings of the United States National Museum Vol 76, Art 6 New Species of Buprestid Beetles from Costa Rica By W. S Fisher (No 2808) Pp. 23 Vol 76, Art 16. Oolites or Cave Pearls in the Carlsbad Caverns By Frank L Hess (No 2813) Pp 5+8 plates (Washington, D.C Government Printing Office )

Comite National Français de Geodésie et Géophysique Assemblee générale du 27 mars 1929 Compte rendu publie par le Secrétaire général G. Perrier Pp 64 (Paris )

Wisconsin Academy of Sciences, Arts and Letters. The Fresh Water Mollusca of Wisconsin By Frank Collins Baker Part 1 Gastropoda (Wisconsin Geological and Natural History Survey, Bulletin 70, Part 1 ) Pp. xx+507+28 plates Part 2· Pelecypoda (Wisconsin Geological and Natural History Survey, Bulletin 70, Part 2 ) Pp. vi+495+plates 29 105. (Madison, Wis )

Meddelelser fra Kommissionen for Havundersøgelser Serie Fiskeri. Bind 8, Nr 6· An Investigation of the Stock of Plaice in the Southern Horns Reef Area in the Years 1925 and 1927 By Aage J. C Jensen Pp. 68. 4.50 kr. Bind 8, Nr 7. On the Age and Growth of the Coalfish (*Gadus virens* L.), the Norway Pout (*Gadus esmarki* Nilsson) and the Poutassou (*Gadus poutassou* Risso) in Icelandic Waters By Bjarni Saemundsson. Pp 87 3.65 kr Bind 8, Nr. 8 On the Influence of the Size of the Stock of Cod upon the Yield of the Herring Fishery in the Kattegat, Belt Sea, and Western Part of the Baltic, and some other Causes of Variations in the Cod and Herring Fisheries. By Aage J. C. Jensen Pp. 16. (København C A Reitzels Forlag )

The Rockefeller Institute for Medical Research. Organization and Equipment. Pp. 27+2 plates. (New York City.)

U.S. Department of Agriculture Technical Bulletin No 112: Biology of the Cotton Boll Weevil at Florence, S C By F A Fenton and E W Dunnam. Pp. 76. 20 cents Leaflet No 48: Reindeer Recipes. By Louise Stanley and Fanny Walker Yeatman. Pp. 8 5 cents. (Washington, D.C.: Government Printing Office.)

Records of Changes in Color among Fishes. By Charles Haskins Townsend. (New York Aquarium Nature Series ) Pp. 58 (27 plates). (New York: New York Zoological Society.)

Proceedings of the Boston Society of Natural History Vol 39, No 5 Experiments in Bird Migration 1 Manipulation of the Reproductive Cycle, Seasonal Histological Changes in the Gonads By William Rowan Pp 151 208+plates 22 32 (Boston, Mass )

Zentralanstalt fur Meteorologie und Geodynamik Publikation Nr 133 Jahrbücher der Zentralanstalt fur Meteorologie und Geodynamik Amtliche Veröffentlichung Jahrgang 1926, Neue Folge, Band 63 (der ganzen Reihe Band 71) Pp xx+A42+B54+C44+D7 (Wien Gerold und Komp )

Parki Narodowe w Polsce National Parks in Poland By Władysław Szafer Pp 31 (Krakow Nakładem Państwowej Rady Ochrony Przyrody )

Państwowa Komisja Ochrony Przyrody w Polsce State Commission for the Protection of Nature in Poland Nr 8 On the Protection of Nature in Poland during the last Five Years, 1920-1925 By Prof Dr Władysław Szafer Pp 54 Nr 24 Loi pour la protection de la nature en Pologne Par Jan Gwalbert Pawlikowski Pp 11 (Krakow Nakładem Państwowej Komisji Ochrony Przyrody )

Publikationer og mindre Meddelelser fra Københavns Observatorium Nr 66 Formeln und Tafeln zur Bestimmung parabolischer Bahnen Von Bengt Stromgren Pp 146 (København )

U S Department of the Interior Education Bulletin, 1929, No 32 Developments in Rural School Supervision By Annie Reynolds Pp v+17 (Washington, D C Government Printing Office ) 5 cents

The University of Chicago Publications of the Yerkes Observatory Vol 7, Part 1 Radial Velocities of 500 Stars of Spectral Class A By Edwin B Frost, Storrs B Barrett and Otto Struve Pp. vii+79 (Chicago University of Chicago Press, London Cambridge University Press )

United States Department of Agriculture Technical Bulletin No 86 Imported Insect Enemies of the Gipsy Moth and the Brown tail Moth By A F Burgess and S S Crossman Pp 148+6 plates (Washington, D C Government Printing Office ) 50 cents

CATALOGUES, ETC

Calendar for 1930. (London British Museum (Natural History) )

Scientific Instruments Pp 80 (Delft P J Kipp en Zonen )

## Diary of Societies.

*FRIDAY*, DECEMBER 20

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Informal Meeting), at 7 —Determination and Isolation of the Picture

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7 30 —W Challis Line Signalling on the Southern Railway

SOCIETY OF DYERS AND COLOURISTS (Scottish Section) —P Urmston Modern Machinery in Dyeing, Printing, and Finishing

PAPER MAKERS' ASSOCIATION (Technical Section, Northern Division) (at Engineers' Club, Manchester) —R H Clapperton The Elimination of Dirt from Paper Stock

*SATURDAY*, DECEMBER 28

ROYAL INSTITUTION OF GREAT BRITAIN (at Institution of Electrical Engineers), at 3 —S R K Glanville How Things were done in Ancient Egypt (Christmas Lectures) (1) The Elementary Use of Nature

### CONFERENCE.

DECEMBER 20 AND 21

SOCIETY FOR EXPERIMENTAL BIOLOGY (at London School of Hygiene and Tropical Medicine)

*Friday, Dec* 20, 10 A M to 1 P M —A. D Ritchie Reflex Movements in Pecten.—G S Carter Thyroxin and Fertilisation in *Echinus* —F C Stott Temperature Optima in Invertebrate Digestive Enzyme Reactions —F C Steward Diffusion of Substances through Membranes of Plant Tissue —M C Pratt Production of Formaldehyde in Photo synthesis —H R Hewer Variation in the Genus *Zygæna*

2 15 to 3 45 —M Robertson The Action of Acriflavine on *Bodo caudatus* —A B. Appleton The Nutritional Factor in the Growth and Differentiation of the Skeleton of the New born Rabbit —H G Newth· The Feeding of Ammocœtes

3 45 to 5 15 —*Demonstrations* —Dr V. J Wigglesworth. The Formation of the Peritrophic Membrane in Insects —Dr. P. A Buxton Apparatus for Exposing Insects to Known Temperatures and Humidities —Dr G. S. Wilson (*a*) Apparatus for the Continuous Passage of Gaseous Mixtures of Variable Composition through Liquid Cultures of Bacteria, (*b*) Apparatus for the Cultivation of Bacteria in Closed Atmospheres of Known Composition —Major H C Brown and Dr J C Broom Portable Apparatus for the Determination of Hydrogen Ion Concentration —Dr A Robertson *Trypanosoma cruzi*, isolated from an Opossum in Honduras —H N. Howes Histological Methods for Investigating the Activity of the Anterior Pituitary —Dr G P. Crowden (*a*) Audiometers for Testing Acuity of Hearing, (*b*) Whipple's Test for Steadiness of Hand, (*c*) Lehmann Muller Closed Circuit Metabolism Apparatus

5 15 to 6 15 —W Robinson Problems of Nutrition and Development in some Brown Seaweeds —V. C. Wynne Edwards On the Waking-time of the Night jar

At 6 15 —Annual Meeting

*Saturday, Dec.* 21, 10 A M to 1 P M —E A Spaul The Distribution of Biological Activity in the Anterior Pituitary —G Pincus Observations on the Living Eggs of the Rabbit —E. M Stephenson The Physiology of Crustacean Chromatophores —R H Stoughton Cytology of *Bacterium malvacearum*.—G Fox Wilson Biology of *Tylenchus dipsaci* in its Relation to Herbaceous Plants

SATURDAY, DECEMBER 28, 1929.

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## Pleistocene Man in China.

NEWS arrived by cable on Dec 15 of the discovery in the cave at Chou Kou Tien of the fossilised fragments of ten more examples of *Sinanthropus*, certainly the most remarkable find of early Pleistocene human remains that has ever been made. Amongst these is said to have been a complete skull with both the cranial and facial bones perfectly preserved This discovery was made by a group of geologists and anthropologists representing the Geological Survey of China and the expedition endowed by the Rockefeller Foundation.

The credit of recognising the importance of the site where these fossils have been found belongs to Prof J G Andersson, the Swedish geologist, who, in conjunction with Dr Grainger, the palæontologist of the American Museum of Natural History, surveyed the field in 1927 Continuing the investigation, Prof Andersson, in association with his fellow-countryman Dr. Birger Bohlin, who is now a member of Sven Hedin's expedition in eastern Asia, found the first tooth of the Peking man for which Prof Davidson Black, of the Peking Union Medical College, created the new genus and species *Sinanthropus pekinensis* This discovery, and also that of a second tooth, have already been described by Prof. Davidson Black in our columns (NATURE, Nov. 20, 1926, p 733, and Dec 31, 1927, p. 954) A year ago fragments of two skulls, one of a child and one of an adult, including parts of the jaws and of the brain cases, afforded a definite confirmation of the validity of Davidson Black's new genus Now comes the astounding discovery of remains of ten individuals, which should provide the material for the study of early Pleistocene man such as anthropologists hitherto had scarcely ventured to hope to find

In a recent letter Dr. Davidson Black stated that before Aug 31 a number of interesting finds had been made at Chou Kou Tien, including six beautifully preserved teeth of *Sinanthropus* forming part of an additional individual, that is, additional to the two originally discovered and some yards away from the spot where they were found. Father Teilhard and Mr. Young have almost completed the preliminary report on the geology of the deposit, and it was hoped to have this report, for the writing of which Father Teilhard is responsible, published before Christmas. This very important step in the programme of research will be followed by a revised and extended list of the fauna which it is expected will be ready before next spring. The material which is now prepared for investigation is

so rich that most of the doubts about the identification of the species of animals will be cleared up and many additions will be made to the earlier list prepared by Dr. Zdansky

The work has grown to such proportions that it has been necessary to extend the laboratories at the Peking Union Medical College to make room for no less than twenty-five technical assistants who are engaged in developing the fossil remains of the associated fauna Prof Davidson Black himself is doing all the preparatory work on the human material, which will take many months to develop His communication, to which reference has already been made, was written six weeks before the new material announced by cablegram on Dec 15 came to light With this extraordinarily rich material we are promised a most important contribution to our knowledge of one of the three earliest members of the human family that have so far been discovered On Dec 29 Prof. Davidson Black will make an official statement on the new discoveries

## Science in Crop Production.

*The Application of Science to Crop Production an Experiment carried out at the Institute of Plant Industry, Indore.* By Albert Howard and Gabrielle L. C. Howard. Pp v+81+12 plates. (London: Oxford University Press.) 9s net.

IN many countries, up to the War period, the career of agricultural research was one of struggle and piecemeal growth. Exceptions were to be found in the steady evolution of research institutes in some European countries, the United States had inaugurated a wide organisation; and in India an interesting feature was the establishment of certain 'central' research stations. Tropical agricultural research was, in general, under neglect The decade now ending will always stand out as a period of informed interest and of determination to develop agriculture by application of the sciences. It is of the British Empire that this is particularly true, and the Imperial Agricultural Research Conference of 1927 may prove to merit a permanent place in the history of agricultural development

Movement has been in a number of directions. Apart from expansion of existing centres, there has come 'industry' research as exemplified in the Empire Cotton Growing Corporation's Research Station in Trinidad and the Rubber Research Institute in Malaya. The new Amani Institute in East Africa represents a novel form of 'central' research station, while the Imperial College of Tropical Agriculture in Trinidad gives the Empire its first tropical training ground Agricultural research councils have recently been set up for the non-self-governing colonies and for India. From this new activity are emerging many problems, ranging over finance, the sciences, organisation, and local political situations, and extending down to the recruitment, training, and status of the research worker This is pre-eminently, therefore, a time which makes welcome any logical survey of the methods of inaugurating and conducting agricultural research on a large scale

In the volume before us, Mr. and Mrs Howard relate the story of the genesis, scope, and experimental work of the recently founded Institute of Plant Industry at Indore, Central India. Central India, a group of Indian States, is a large tract in which 'black cotton soils' predominate In 1919 it was decided to found an agricultural research station for the whole area, and Mr Howard became Director of the Institute and Agricultural Adviser to States in Central India and Rajputana. Gifts of land and money were made by the States, and in 1924 the recently formed Indian Central Cotton Committee provided buildings and equipment and guaranteed a substantial annual income By 1928 the Institute was incorporated and made fully autonomous; it is now financed by subscription and controlled solely by the subscribers Thus was removed one of the difficulties of organised research, and one which the authors believe to have been a grave defect in British India, namely, the oppressive official control of work and organisation by way of official control of funds. The circumstances of Central India made the broad task of the Institute clear. Work was concentrated upon cotton and along the following main lines. fundamental investigations on cotton, especially in relation to the characteristics of black soils and the production of improved varieties for those soils; the training of post-graduates and others; and the general stimulation of agricultural development in Central India.

General policy and development at Indore are of especial interest when taken as an illustration of the general case. The major considerations which are steadily associating themselves with large-scale agricultural research are grouped round experimental policy; organisation including finance; and the means of projecting research results into farming practice.

Upon experimental policy there are two rather divergent schools of thought One would content itself with finding really competent research workers in the various sciences and giving them full working

facilities and full freedom It argues that all fundamental advances must in time inspire improvements of practice and that economic applications arise, and may be left to arise, unexpectedly from unfettered research In contrast, the second school favours a survey of the economic situation and the practices of production, in the light of which a limited number of urgent but approachable problems should be selected Experimentation should then be specifically directed to these problems It should commence with a strong 'applied' bias and gradually find its way into the underlying fundamental scientific problems In support of this it could be urged that any crop or domesticated animal offers literally infinite scope for experiment, that resources are limited, and that, therefore, the direction of research must to a fair extent be prescribed In brief, the problem of guiding experimental policy is to maintain a live connexion with the practices of agriculture without depriving research of that measure of freedom which is vital to all scholarship Flexibility of outlook is the fundamental necessity, for time and circumstance are bound to give suitable scope to both the alternative attitudes At Indore, it is clear, faith in the man rather than the organisation has been the guiding principle, and yet the economic bias has not been forgotten, for science is being applied to crop production by progressive analysis of a number of clearly defined practical problems.

The organisation of a research institute involves finance, government, internal administration, staffs, buildings, and equipment. In connexion with each of these, current practice varies widely among agricultural research centres Indore, by reason of the agricultural and political circumstances of Central India, is saved from many of the difficulties familiar elsewhere It is, none the less, an extremely interesting example. In finance there is complete autonomy, and to this the authors attach great importance. By most praiseworthy restraint the Board of Governors has been limited in number to seven, of whom one, the Agent to the Governor-General in Central India, is *ex-officio* president. Three of the members represent the constituent States and three the Indian Central Cotton Committee. This body, small, and directly concerned in the ultimate aims of the Institute, may perhaps be looked on as, in principle, ideal of its kind. For it is unlikely to lose touch with essential aims by dissipating itself into committees the time of which is taken up by the *minutiæ* of internal administration. One of the most interesting chapters in the volume describes the lay-out and development of land and buildings, the stock, the equipment, and the working material in general It is a rare and valuable guide for future undertakings

How to project research results into agricultural practice is the remaining major consideration. Its great importance has in the past rarely been appreciated either by the research worker or by government or other financing body In England it has been by no means neglected, and yet there are many farmers who, in such familiar practices as the use of fertilisers, still fail entirely to profit from the clear-cut principles which have long been familiar to science At Indore the general problem has been resolved into liaison on one hand and the scope and status of the Station on the other. Students trained and sent out into the States are regarded as the most effective agents for liaison with the supporters of the Institute With the help of a certain number of scholarships, it has been possible to commence the training of Indian university graduates as specialists in cotton Agricultural officers and subordinates are urgently needed for the contributing States, and arrangements have been made to train present occupants of these posts and to recruit new ones The aim is not so much to afford a knowledge of agricultural science as to stimulate an informed interest in the development of the countryside A novel and most valuable feature has been a short course for a certain number of State officers connected with the revenue departments. Training, or the making of liaison agents, is extended even to the cultivator. The labour staff of the Institute is maintained as a fluid body from which trained men are gradually drafted to the districts where, in various capacities, they are expected to become the foci of an improved agriculture

Indian experience has made clear, the authors feel, that a 'central' research station as formerly conceived, cannot succeed Unless it produces results of economic value it will sink in the general estimation and lose financial support. But if it produce such results, how is it to ensure that they are adopted in practice? In British India the provincial stations are the only medium available. These, however, have duties, interests, and researches of their own, and, in effect, cannot subserve the central station. It is urged, therefore, that, together with the central station for any 'area', there should be established demonstration farms in the component 'districts'. These should engage in no scientific work, but concentrate on inducing the cultivator to adopt the improvements emanating from the central station. Indore is conceived

upon these [illegible] and the States are providing the necessary demonstration farms It is, perhaps, a fair criticism that in some countries this simple partition of 'research' and 'demonstration' would offer difficulties. Men sufficiently competent and interested to have charge of demonstration farms and propaganda would not always be willing to eschew investigation and subdue originality. Moreover, for areas varying sharply from place to place in soil and other circumstances, full experimental confirmation of central station results in representative districts would be essential

Of actual experimental achievement, despite the short life of the Institute, there is a good deal to show. The comprehensiveness of the policy is a noteworthy feature, and the essential aim is to study the cotton plant as actually grown by the cultivators. Improved varieties usually offer, in circumstances of somewhat backward husbandry, the readiest chances of advancing agriculture, and, provided a seed supply be organised, they are the swiftest means of gaining the cultivator's good will. But, even in India, increases in yield from improved varieties are usually of the order of only 10 per cent Far more substantial increases may be effected by cultivational improvements, and the authors hold that on the black soils better methods may be expected to double the output per acre of cotton With plant breeding are therefore linked extensive studies upon weed eradication, upon the control of water during the monsoon to prevent erosion and soil deterioration, upon soil permeability; and upon the organic matter content of black soils It is believed—and the experiments now bear witness—that in these four questions are to be found the essential limitations to output per acre. Well-irrigation, the maintenance and improvement of stock, and appropriate ploughs, crushing mills, and other mechanical appliances, are further subjects of investigation To ensure that improvements in these directions pass into practice, the Institute arranges supplies to cultivators on simple financial terms.

In each of the fields selected the experimentation projected or in progress is very comprehensive. Moreover, while closely regarding the underlying fundamental scientific questions, it is directly linked with the circumstances of husbandry. Plant breeding is based upon a study of all obtainable forms of Indian cotton, to which will be added, later, other Old World cottons. Botanical surveys of Indian cottons have already been made, but these, for plant breeding and husbandry, are of no more than cataloguing value. The quality or manufacturing characteristics, the adaptation to soil, season, and cultivational practice, and resistance to diseases and pests, are of first importance. To all of these close attention is being given, and this wide survey must inevitably assist improvement in many branches of crop production

The Indore Institute is itself an experiment Its avowed aim—the application of science to crop production—is clearly reflected in both general organisation and experimental policy Some of its features are novel, and some have been pre-determined by the circumstances of the area it serves. As an agency—the central agency—in the agricultural advancement of Central India, its strong potentialities are already manifest As a new model it will claim the close interest of all to whom it falls to create or maintain centres of agricultural research.

F L ENGLEDOW

## Sir Ronald Ross and Malaria.

(1) *Studies on Malaria.* By Sir Ronald Ross. Pp. xii + 196 + 4 plates. (London: John Murray, 1928) 5s. net.

(2) *La découverte de la transmission du paludisme par les moustiques* Par Sir Ronald Ross. (Une grande page de l'histoire de la médecine) Préface et traduction de l'anglais par Dr Charles Broquet. Pp 175. (Paris: Norbert Maloine, 1929.) 20 francs.

(3) *Letters from Rome on certain Discoveries connected with Malaria.* By Dr T Edmonston Charles, and Addenda, consisting of an article by S. Calandruccio, letters from Robert Koch and A. Laveran, and a statement by Lord Lister. Edited, with a Preface and Remarks, by Sir Ronald Ross. Pp 78 (London. Sir Ronald Ross, Ross Institute and Hospital for Tropical Diseases, 1929)

(1) SIR RONALD ROSS has prepared this summarised and readable account of his work on malaria for the benefit of numerous correspondents who desire a small and convenient volume on the subject. In the first chapter the earlier years of the author up to 1894 and the work of Laveran and Golgi are briefly reviewed, and in the second and third Sir Ronald describes the difficult conditions under which his observations on the development of the parasites of malaria in mosquitoes were begun and carried on in India. The next chapter is a re-statement of the unfortunate controversy with the late Prof. Grassi and his colleagues.

In 1899, Ross arrived in England and was

appointed lecturer on tropical medicine in Liverpool, and almost at once went out on the first expedition to Freetown. He describes his observations and the lack of response on the part of the Colonial Office to representations in regard to measures based on these observations, and the cheering effect of the gift of £2000 from Mr. Coats for a year's trial of the plan for mosquito control. The second expedition to Freetown was then planned as an object-lesson in mosquito reduction, and an account follows of the work of Dr Logan Taylor there. Visits were made to Lagos and the Gold Coast, where Sir Ronald records that he had a more appreciative reception, and to Ismailia, where methods for mosquito reduction were entirely successful Visits followed to Panama, to see the results of the work of Gorgas, and to Greece and Mauritius.

Ross resigned in 1912 the chair of tropical medicine in Liverpool, which he had held for ten years, and commenced practice in London War service, the petition by the author for a monetary compensation for his work, and the foundation of the Ross Institute in 1923 are briefly dealt with, and in a final chapter is a summary of the main facts about malaria A list of 108 references is appended.

(2) This is a translation of "Researches on Malaria", prepared by Ross for his lecture in Stockholm in December 1902, when he received the Nobel Prize, and reprinted in the *Journal of the Royal Army Medical Corps*. Ross's drawings of the stages of the malaria parasite in the mosquito are reproduced in nine plates and seven text figures. In the preface Dr. Broquet gives a short biography (28 pp.) of Ross and a review of his chief works.

(3) The letters from Rome were first privately printed in 1900, but only a few copies were issued —in February 1901 The present edition is prepared for "those who study the history of medicine and who prefer truth to fiction". The letters, eight in number, were written from Rome by Dr. Charles to Major Ross in Calcutta between Oct. 4, 1898, and Jan 14, 1899. Dr Charles reported to Major Ross the investigations on human malaria then being carried out in Rome by Prof. Grassi and his colleagues, and he obtained from Ross specimens of the mosquitoes studied by him in India and from Manson one of Ross's microscopic slides showing zygotes of *Proteosoma*—the organism of bird malaria the cycle of which was the subject of Ross's work in India. These specimens and others sent by Ross to Charles were shown to Grassi and his colleagues. Dr. Charles, in fact, acted as the intermediary between Ross and Grassi for the ten weeks covered by the letters.

In the second of two postscripts, Ross states that "the whole of the Italian work depended on my discovery of the zygotes", and that when the Italians "took up the work it no longer presented any serious difficulties". That is Ross's position and is the reason for the republication of these letters. As Profs. Grassi and Bignami, the chief two Italian workers, are dead, it would be well to let the controversy cease.

Appended is a list of publications on the transmission of malaria, bearing dates from Dec. 8, 1894, to Dec. 22, 1898—the period concerned in the discussion of priority.

## Reform of the Calendar.

(1) *Report of the National Committee on Calendar Simplification for the United States, submitted to the Secretary of State, Washington, August 1929* Pp 119. (Rochester, N Y . National Committee on Calendar Simplification, 1929 )

(2) *Thirteen-Month Calendar* Compiled by Julia E. Johnsen. (The Reference Shelf, Vol 6, No. 4 ) Pp. 201. (New York: The H W. Wilson Co, 1929.) 90 cents

IF one may judge by the publications before us, the question of reforming the calendar has made considerably more headway in the United States than in Great Britain. The American National Committee was formed in response to a suggestion received in 1927 from the League of Nations. From the beginning, Mr. George Eastman, of the Eastman Kodak Company, took a keen part in its organisation, and became its energetic chairman. The composition of the committee was fairly representative of all interests, with one rather significant exception. It was not found practicable to include a section to represent the views of the various religious bodies, and the attempt was frankly abandoned.

The result of circulating a questionnaire and collecting already existing evidence on the subject is to show a wide interest in calendar reform on the part of a large body of American opinion. So far as this favours a particular plan, it is the fixed calendar of thirteen months which finds the largest measure of support. As this is the most drastic type of scheme and is open to the most obvious superficial objections, and alternative schemes are passed over very lightly, the impartiality of the committee may not appear above suspicion. But its practical conclusion is that a decision on

only be arrived at by an international conference, that the United States Government should express its willingness to participate at an early date, and that the American representatives should not be committed to any particular scheme of reform No other view, except a purely negative one, is possible, for it may be taken as common ground of all enlightened opinion that any contemplated change must be introduced universally and simultaneously

The extent of the propaganda behind the movement in favour of a calendar of thirteen months is shown perhaps even more clearly in the second volume, which gives in a clearly arranged form a summary of the arguments (for and against) reduced to heads, bibliographical notes, and excerpts from the literature of the subject. This should be found very useful and instructive. The desire for a change comes most urgently from the part of those concerned in business management, and naturally from those quarters where it has been found most convenient to adopt a month of four weeks as the unit of accounts. Perhaps the arguments based on experience in this connexion sometimes overshoot their mark Thus the comptroller of the Western Clock Company has pointed out very cogently the advantages which have followed from adopting this system in his business. But these have been gained by a domestic arrangement equally open to others, with little or no hindrance arising from the anomalies of the present calendar There is much scope for the judicious use of a private calendar, designed for special needs, without waiting for a revolution which may be a long time in coming In the domain of meteorological statistics, for example, it is conceivable that the adoption of some world-wide scheme by agreement would confer greater advantages than those which may be expected to follow automatically from the introduction of a new civil calendar

The movement is not free from the two-edged and even sordid type of argument to which the ardent propagandist is prone. A specimen may be quoted:

> "It should increase your business. When the new calendar is in general effect all monthly periodicals would be issued thirteen times a year instead of twelve
>
> "There will be an increase in the amount of printing of bills, statements, etc."

Such arguments may account for some of the definite support behind the movement, but they will scarcely advance the case. Nor is the argument that a reformed calendar would be more scientific in the least impressive To smooth out the existing irregularities of the present calendar is too simple a task to present a scientific problem, and men of science will be the last to allow their own interests any excessive weight in the solution of it. The question is mainly social and religious, and must be decided by political and religious agreement In the meantime, the fixing of Easter within narrow limits, a simple object of some importance to many, seems likely to be hindered indefinitely by the search for an ideal calendar acceptable to all interests.

H C P.

## New Six-Language Technical Dictionary.

*Pitman's Technical Dictionary of Engineering and Industrial Science in Seven Languages—English, French, Spanish, Italian, Portuguese, Russian and German.* Compiled by Ernest Slater Vol 1 *A-Dec.* Pp. x+581 Vol. 2: *Dec-Knu* Pp. iii+582-1155. Vol. 3· *Lab-Rib.* Pp. iii+1156-1727 Vol 4. *Rib-Zon.* Pp. iii+1728-2211 (London Sir Isaac Pitman and Sons, Ltd., 1928-1929.) 4 vols., £8 8*s.* net

THIS monumental work is more than a mere dictionary, and certain of the preliminary sections might be read with advantage by all who have to do with the translation of technical matter into foreign languages or have business relations with firms abroad.

The book originated with a small group of translators—most of them trained engineers—who took as their basis a list of terms collected abroad during some years and amplified this by reading and marking journals and text-books of the various countries in question This procedure, supplemented by correspondence with engineers in other countries, has given the foreign equivalents, not merely for ordinary engineering terms, but also for many workshop slang expressions

The first intention was to treat of each branch of engineering in a separate volume, the inclusion of the whole in a single book being decided on when it was found that about 60 per cent of the entries for any branch must consist of more or less general engineering terms Thus, the volume on steam engines would not be complete without considering pipes and pipe-joints, which would be equally essential when treating of water or gas engineering, and such matters as plates, rivets, bolts, and girders figure in many departments of engineering.

The dictionary proper is preceded by several

sections in which special difficulties are discussed Section 1, "The Art of Technical Translation", furnishes useful information as to the way many of the expressions in common use are to be converted into the corresponding foreign phrases Section 2, on "Alternatives, Refractory Idioms, and Peculiar Phrases", considers the correct renderings of alternating, back gear, booster, coal of various grades, control, efficiency, head, jam, oil, patch, soldering and brazing, temper, tool, weir, and a number of other terms, of which the translation into certain languages demands special care.

Section 3 gives a record of untranslatable English words adopted in their original form into other languages, while Section 4 indicates how phrases referring to mechanical motion, relation, position, cause and effect, are expressed in each language; idiomatic forms commonly used in advertising are also included here. In Section 5 there is laid down a guide to common engineering abbreviations, and to technical and scientific signs, contract conditions, specification matter, engineering slang, shop terms, etc.

The dictionary itself extends over more than 2100 pages ($9\frac{1}{2}\times 7$ inches), each of four columns, one side being devoted to English-French-Spanish-Italian and the opposite one to English-Portuguese-Russian-German. This arrangement has involved duplication of the English column, but it prevents the confusion that might arise from faulty alinement Every page contains from forty to fifty entries

As regards most branches of engineering, the book appears to be as nearly complete as it is possible to make it. Entries relating to air, for example, occupy six, to coal more than six, to oil six, and to sugar four sides. On the other hand, although the sub-title includes the word chemistry, the list of terms relating to chemical engineering subjects is not nearly so full as might be desired. To take the important question of distillation alone, the terms reflux and drip-pipe are missing, and for bell the French equivalent is given only as 'cloche', 'calotte' not being mentioned. Such terms as cream of tartar, nitre, soda ash, and pyroligneous acid are found, but salt cake, vinegar, brewing, and a number of others are absent.

The book has been well produced and opens well at any page. The type in the main body of the dictionary, although clear, is rather small, but this is doubtless due to the necessity for keeping the bulk within reasonable limits. In the Russian column the old spelling, not that now in use in Soviet Russia, has been adopted A few minor misprints have been noticed, but in general great care has been taken in the correction of proofs

The dictionary may be cordially recommended for purposes of technical translation from English into any of the other six languages, but it does not serve for translation into English To this extent it is less useful than the Deinhardt and Schlomann series of illustrated six-language technical dictionaries, which contain complete indexes, although they do not comprise Portuguese

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## A Modern Platonist.

*Matter, Life and Value* By C. E. M Joad. Pp xviii+416. (London: Oxford University Press, 1929.) 18*s* net.

THIS book, which is Mr. Joad's philosophical confession of faith, is an interesting and very readable work The author is opposed to the tendency prevalent among philosophers of reducing the number of real independent entities in the universe in the supposed interests of logical consistency. Mr Joad argues forcibly against various types of monistic philosophy, and for himself is prepared to admit the existence of the three types of entity mentioned in the title and to base his system of philosophy on this division in spite of any logical difficulties that may arise

The style of writing is always lucid and pleasant and sometimes eloquent The views of others are well and fairly discussed. The author's own views are stated modestly without trying to disguise the difficulties involved or pretending that only a fool could think otherwise Along with these qualities the book has marked defects which appear to be the result of carelessness and haste Many books on scientific subjects are of necessity written in a hurry because their interest is ephemeral, but a philosophical work, if it is worth reading at all, is equally worth reading in ten years' time and is none the worse for a little care and deliberation. The intervention of an editor armed with a large blue pencil might have worked wonders Among other things, he would have eliminated the first chapter or had it rewritten. This chapter professes to give a criticism of classical scientific materialism and to state the scientific evidence in favour of admitting life as an autonomous principle or activity distinct from matter. It is quite the worst thing in the book and is likely, standing where it does, to prejudice the reader against the rest of the book. The author apologises for his first chapter, it is true, but it is not apologies that are needed The defects are not

fundamental: that is to say, the author has an intelligible view to put forward, they are chiefly a matter of looseness and carelessness of expression. The most glaring error, though in its context it is trivial, is the statement that ". . . the principle of entropy was not known to nineteenth-century physics" (pp 9-10)

Another example of careless expression is seen later on where the question of 'values' is being discussed The author in stating his æsthetic theory deals primarily with the subject of music—an interesting and, to the reviewer at least, an illuminating discussion. Having explained that music is not properly concerned to represent or symbolise either objects of the physical world or human activities or relations, and that it is therefore in a quite definite sense meaningless, he then produces the startling definition that music which produces its proper and intrinsic effect is to be called 'significant music' (p. 285). The definition is harmless if the reader keeps in mind that the word 'significant' does not mean significant, in fact does not mean anything; but it is very careless. The reason for the use of this unsuitable word appears to be that Mr. Joad has been bemused by that catch-word of the second-rate art critics, 'significant form' (pp. 299-304). Lastly, the book as a whole is too long for the amount of matter it contains, and many passages are rambling and diffuse.

Mr. Joad is a Platonist, as many English philosophers have been He is generally at his best when he is most purely Platonic; his ideas then are clear and firmly developed. But when he draws on the theories of modern thinkers—and he does this in a curiously promiscuous way from Schopenhauer, Bergson, Whitehead, and Bernard Shaw—the reader gets the impression of confusing eddies and cross currents breaking up a smooth current of thought It is as though he cannot bear to let go any philosophical idea that appeals to him, but must add it to his collection, however incongruous it may be.

A. D. R.

## Our Bookshelf.

*A School Certificate Chemistry.* By G. H. J. Adlam. Pp. x + 334. (London: John Murray, 1929.) 4*s*. 6*d*. net.

DURING the last few decades much attention has been given to the methods of teaching science, especially chemistry. Definite courses of instruction have been framed for educational purposes, and they have tended to become stereotyped in conformity with the requirements of examining bodies. The subject matter of the science, however, has not received a similar careful scrutiny, and, whilst in the outside world epoch-making advances have been made, they have passed unheeded in the classroom. There is thus a danger that a distinction may soon be drawn between chemistry and 'schoolmaster's chemistry'. It is with this in mind, evidently, that Mr Adlam has written his volume for elementary students, in which recent industrial methods receive preference over the obsolescent, uneconomic preparations of the average elementary text-book.

Mr. Adlam sees no reason why the newer, large-scale methods of producing inorganic substances should not be adapted for teaching purposes. Thus, the steaming of red-hot iron is preferred to the action of zinc on sulphuric acid for preparing hydrogen. For lecture purposes this is excellent, but for a class of young students it is impracticable. Oxygen is prepared (p. 18) from sodium peroxide and water, whereas the usual laboratory method, by decomposing a mixture of potassium chlorate and manganese dioxide, is only mentioned incidentally, emphasis being placed upon the fact that it affords a good example of catalytic action. Again, the synthesis of ammonia from nitrogen and hydrogen (from water gas) is simple enough in theory to take its place beside the decomposition of ammonium salts with lime. Nitric oxide and nitrogen peroxide are now made synthetically as intermediates in the manufacture of nitric acid, so that the complicated reactions of nitric acid with various metals are only given a subsidiary place in Mr Adlam's book.

From a perusal of this work, it is readily apparent that the author has endeavoured to turn to account for teaching purposes the modern large-scale methods for the manufacture of common chemicals. The traditional laboratory methods, which are also included, are relegated to the background.

*In African Game Tracks: Wanderings with a Rifle through Eastern Africa.* By F L Puxley. Pp. 320 + 8 plates. (London: H. F. and G. Witherby, 1929.) 12*s*. 6*d*. net.

ONE is frequently being reminded that the reading public cares little for precision of detail. So long as it seems interesting and the author's style makes for easy reading, any book on African sport or travel has apparently a successful life, while one dealing with actual fact and truly related incident is a slow seller. The book under notice is probably to be placed in the former category. Its author has had a long and varied experience in many spheres of African life since 1896, mainly, as he says in his foreword, in regions lying between the Sudan and the Cape, but from what he says about "Sese Island" in Lake Victoria and the sitatunga, which he spells sitatungu, he writes of one place at least which he has not visited. The islands of the Sese group are for the most part fairly high and wooded, not surrounded with wide and deep papyrus swamps, as he states, nor are they suited to the sitatunga, which inhabits a small island much farther out in the lake.

The first half of the book deals with incidents, things, and people belonging to South African his-

tory, about which much has been written, but it is nevertheless all interesting reading. The chapter on whaling off the Durban coast is especially so, for little has appeared in print on the subject, probably for the reason that when the animal has been sighted, chased, and harpooned, the excitement changes to butchery and malodorous operations. The information given on tsetse flies, sleeping sickness, and kindred subjects reads like knowledge of long ago, but in spite of its inaccuracy of detail, the book, with its wealth of hunting incident and descriptions of bush life, is a very readable one

*Physics of the Air.* By Dr W J Humphreys Second edition, revised and enlarged Pp xii + 654 (New York McGraw-Hill Book Co, Inc ; London: McGraw-Hill Publishing Co, Ltd, 1929) 30*s* net.

THE first edition of "The Physics of the Air" was reviewed at length by Sir Napier Shaw in NATURE of Mar 17, 1921. Prof. Humphreys has taken advantage of the opportunity offered by a second edition to meet some of the criticisms levelled at the first A great deal of recent work has been incorporated, and what is even more important, numerous references have been added as footnotes to serve as guides to further reading. The book seems smaller than its predecessor, but that is an illusion, for the decrease in size has been brought about by cutting down the over-generous margins of the first edition The amount of text has actually been considerably increased, while the volume is certainly handier. None of the original matter has been deleted, though much of it has been re-written in the light of the latest investigations.

One of Sir Napier Shaw's criticisms concerned the omission of the important subject of meteorological acoustics. That has now been remedied in a section of 33 pages containing two chapters, the first dealing with effects of meteorological conditions on sound transmission, and the second with sounds of meteorological origin, such as thunder and the howling of the wind The reflection and refraction of sound are discussed mathematically on similar lines to the reflection and refraction of light rays, leading, for example, to the theory of 'acoustical mirage', which is examined in detail. On the other hand, the remarkable phenomena of the 'zone of silence', beyond which sounds may be heard to abnormal distances, are dismissed very briefly, and no actual examples are quoted

The new edition of Prof. Humphreys' work should be in the possession of every meteorologist, and of other men of science whose work deals in any way with the domain of the atmosphere.

*Penrose's Annual: the Year's Progress in the Graphic Arts.* Edited by William Gamble. Vol. 32. Pp. xvi + 168 + 70 + 80 plates. (London: Percy Lund, Humphries and Co., Ltd, 1930.) 8*s*. net.

THE general impression on looking through this volume is that it shows a larger proportion of examples of work in colour, and that of a rather superior quality, when compared with the annuals of the last few years Of course it is impossible to say more than this, and to judge more precisely of the success of the colour imitation, unless the original and the copy are seen side by side.

We have the editor's dictum that though the past year has not been notable for any striking new developments in printing or process methods, there has been quiet and steady progress in almost every branch of the graphic arts Perhaps the greatest advance has been in the method of the chromium plating of printing surfaces It has been found that the current density may be reduced to about a third of what was considered necessary, and that the best deposit is obtained at 68°-70° F.

The effect of colour in advertising is shown in some very interesting results; for example, where the only variant was the tint of the paper used in a circular, for every hundred orders resulting from white paper, blue produced 120, buff 130, green 150, pink 180, but it must not be supposed that pink paper would always be the most advantageous Scientifically considered, the most interesting of the numerous examples is a four-colour reproduction of colour photographs on Agfa plates of four pathological human eyes taken by Dr. L. D Redway of New York City by means of a special apparatus devised by him, the exposure in each case being one-fiftieth of a second.

*Photographic Emulsions their Preparation and Coating on Glass, Celluloid and Paper, Experimentally and on the Large Scale.* By E. J Wall. Pp viii + 256. (London: Chapman and Hall, Ltd, 1929) 21*s*. net.

MR. WALL was specially fitted to write and compile such a work as this because of his varied experience as a manufacturer and as a teacher, his enthusiastic study of the subject, and his excellent memory An index would have added to the convenience of consulting the book, though the detailed table of contents somewhat makes up for this deficiency. The book is full of the descriptions of practical methods of formulæ old and new, though formulæ that are obviously obsolete are not given

The subject is treated in a thoroughly practical manner; the book does not pretend to give theories, though the reasons for the procedure described are given, and also the unfortunate results of the omission of proper precautions. The author says that "as a field for experiment emulsion making is extremely fascinating. As a means of spending money it is only equalled by dabbling in stocks". The information is based on many years of practical experience, but Mr. Wall acknowledges that there are little points which can only be learnt by continued experiment. If the subject is to be attacked seriously, the mere coating and exposure of a few plates and bits of paper will lead nowhere. Accurate photometric testing methods must be used, and the various factors varied one at a time, and it is utterly hopeless to expect good results by working in a dark room that has been used for the ordinary operations of

developing, fixing, etc, because it is impossible to keep such an apartment scrupulously clean The information given must be regarded as sign-posts, indicating the way, rather than as milestones giving definite certainties

*Textile Microscopy.* By L G. Lawrie Pp. 144 (London: Ernest Benn, Ltd, 1928) 25*s*. net.

THE technique employed in the microscopical examination of textile fibres forms the subject of this book, not the appearance and characters of the fibres, as the title might imply Special methods applicable to the microscopical examination of textiles are in fact found only in the last 45 pages, the first 86 pages being devoted to a description of the microscope and its optical principles and of other apparatus, with an occasional reference to the special subject

This first part gives a full though simple account of the microscope and its use, such as would serve as an introduction to any branch of microscopy. These pages, on the whole, are good, but the author is not always so careful in his statements as he might be. For example, alluding to the use of the draw-tube for increasing magnification, the fact that objectives are corrected for a particular tube-length is not mentioned, and though true for critical work, it is an exaggeration to say that the Abbe condenser is "quite unsuitable for high-power work" or that the lack of perfect centration of a nosepiece "causes considerable inconvenience" with high powers.

In the second part of the book a great deal of information is given on the reactions, staining and others, of textile fibres, that it would be difficult to find except in scattered papers. The pages on the microscope and apparatus are profusely illustrated, the large page and glazed paper ensuring excellent reproductions, and three plates of photomicrographs of textile fibres are included These last named features may account for the seemingly high price of the book.

*Climate: a Handbook for Business Men, Students and Travellers.* By Dr. C E P. Brooks. Pp. 199. (London: Ernest Benn, Ltd, 1929.) 10*s* 6*d* net

IN view of the importance of a knowledge of climate in numerous activities and in many lines of research, it is remarkable how few authoritative volumes exist on the subject. For this reason Dr Brooks's volume will be welcome, although we could wish that it had been a little fuller. To cover the climates of the world in two hundred pages, of which several are filled with statistical matter, is summary treatment. But Dr. Brooks wastes no words and manages to compress a great deal into a small space. In order to economise space, he plunges direct into the description of climates based on geographical distribution. He omits all preliminary discussions of physical processes and general meteorological considerations. But this does not mean that the treatment is solely descriptive.

Lucid explanations are given in places, sparingly perhaps for the student, but no doubt often enough for the other categories of readers for whom the book is intended Under each climatic area, meteorological data are given for selected stations, temperature and rainfall for every month of the year, daily range in January and July, extremes, relative humidity for January and July, cloud amount and number of days with rain, snow, and thunder There are only three diagrams. A few bibliographical references are given for each part of the world

*The Growth of the World and of its Inhabitants.* By Prof. H. W. Swinnerton Pp. 211. (London: Constable and Co, Ltd, 1929) 5*s* net.

As a sardine might be shy about biting a whale, one feels diffident at the very idea of criticising Prof. Swinnerton. Yet he makes the author of "Principles" and "Elements of Geology" sole father of that science. Surely Sir Charles Lyell would rather have given Hutton credit for the geology of fire, and Werner for the geology of water; and Hutton would have referred to his master, Black, whose theory of latent heat was the first clue to the story of the rocks.

Again, it is disconcerting to find the theory of land bridges still held in equal esteem with that of continental drift. Some of us took the trouble to visit countries like Greenland, on the so-called North Atlantic bridge. We picked harebells there, and were quite prepared for Suess with his Atlantic rift. It was Greenland which opened Wegener's eyes to the land bridge theory as a superstition; but here it haunts Prof. Swinnerton like a belated ghost.

To do Prof. Swinnerton justice, rarely does he venture into fields of controversy. So far from looking for trouble, he is painfully cautious. He is very lucid, always trying to use simple words, only occasionally blundering into the Græco-Latin jargon which chokes the general reader and so limits the sales of scientific books. Until a Homer or a Shakespeare comes to write these glorious themes, we should be well content with books like this one, sincere, cautious, accurate, written by men of broad views and profound scholarship

*An Introduction to Geography.* By Prof. H J. Fleure. (Benn's Sixpenny Library, No. 91.) Pp. 80. (London. Ernest Benn, Ltd., 1929.) 6*d*.

PROF. FLEURE defines with swift ease the fields of geographic research, and uses each as setting for one or two examples, gems of exposition. There is more in this brief pamphlet than in many a stately book, but finest of all is the description of that oceanic climate wherein the chemistry of heat and moisture creates the humid brown earths in which the beech tree grows, the area of mixed farming and of parliamentary government in nation States, bordered by a broad margin of dictatorships. Human affairs in terms of natural law are almost a new field of research.

## Letters to the Editor.

*[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.]*

### Action of Low Velocity Electrons on Micro-Organisms.

THAT ultra-violet light has a definite lethal action on certain micro-organisms is well known. The nature of this lethal action is being studied extensively, but hitherto (so far as is known) no work has been done to determine the action of low velocity electrons of known energy on micro-organisms. Since electrons and radiant energy seem to be so closely related, it was considered worth while starting a series of experiments in this field. It is the purpose of this note to present an outline of the results obtained to date.

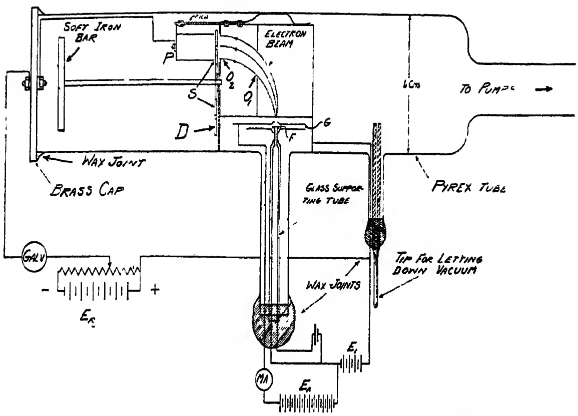



FIG 1.

*Apparatus and Experimental Method.*—Fig. 1 shows the apparatus used, together with a diagram of connexions. Electrons from the oxide-coated filament $F$ are accelerated to the metal plate $G$ by a potential $E_A$ of about 90 volts. Those passing through the opening in $G$ are retarded in passing to the next baffle and enter $C$ with an energy per unit charge equal, very approximately, to $E_1$. Thus by varying $E_1$, electrons of any desired energy can be made to enter $C$. After entering $C$, the beam, deflected in a circular path by a magnetic field, passes through the circular openings $O_1$ and $O_2$, striking the platinum slide $S$, on which there is a thin smear of the organism to be bombarded. The beam is deflected in a circular path for the purpose of eliminating soft X-radiation produced in the vicinity of the filament which preliminary experiments showed is intense enough to kill the organisms. The Faraday pail, $P$, mounted as shown, served to determine the number of electrons striking unit area of the bombarded portion and also to determine the energy distribution of the beam.

Distribution curves were taken with each exposure. These curves showed very good homogeneity of the beam; the curves in each case falling from maximum to minimum within a range of 1·5 volts or less. The vacuum throughout the work was maintained at a pressure of approximately $5 \times 10^{-6}$ mm. Four exposures were made without breaking the vacuum by mounting four slides on the face of the disc $D$, which was turned with a magnet.

*Staphylococcus albus* was chosen as the organism with which to work. A light smear of this organism in beef broth solution was placed on the platinum slides $S$. This, when dry, was placed in the apparatus, and the area (a circle of approximately 0 8 sq. cm. in diameter) in front of the opening $O_2$, Fig. 1, was bombarded for a definite length of time with electrons of known energy. The slides were then removed from the vacuum and, after being carefully covered with strips of moist solidified agar, were incubated.

*Results.*—A series of eighteen exposures with electronic energies ranging from 19 5 volts to 30 volts have been made. In every case exposures in the range of 19 5 volts to 25 volts showed little or no killing, while exposures at higher electronic energies showed definite killing, the total energy falling on unit area of the bombarded surface in each case being constant at $13 \times 10^7$ ergs. The photographs reproduced as Fig. 2 show four typical exposures made with electronic energies of 25, 27·5, 29, and 30 volts. The photograph taken at 30 volts shows almost complete

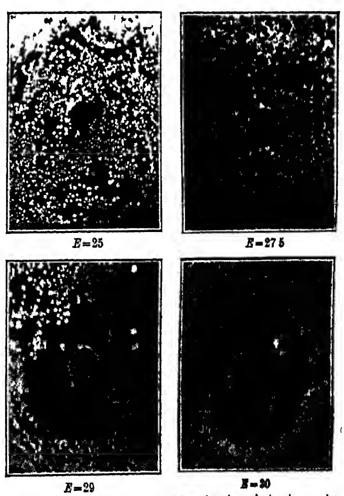



FIG. 2.—Photographs showing the action of various electronic energies. E Total energy per unit area of bombarded surface in each case was approximately equal to 13 joules.

killing over the circular area bombarded Another series of exposures at 30 volts with various values of total energy showed definitely that the lethal action is a function of the total energy per unit area of the bombarded surface. Whether the organisms would be killed at the lower voltages by greatly increasing the total energy remains to be shown by further experiments.

*Summary of Results.*—The results of this work indicate that: (1) *Staphylococcus albus* can be subjected to a vacuum of $5 \times 10^{-6}$ mm. of mercury for so long as eight hours without showing signs of killing; (2) it may be killed by the action of low velocity electrons; (3) under the conditions of this experiment, the lethal action is a function of the energy of the individual electrons; (4) the per cent killed at constant electronic energy is a function of the total energy of exposure.

I wish to express my thanks to Prof. G. Sperti for suggesting the problem; to Dr. George Burger for valuable assistance with the bacteriological phase of the problem; and to the Basic Science Research Laboratory, University of Cincinnati, for making the work possible.

D. A. WELLS.

University of Cincinnati.

## Spiral Forms in Gas Discharges.

THE spiral forms of the high frequency electrodeless discharges observed in organic vapours by Ghosh and Chatterjee (NATURE, Oct. 26, 1929), and in iodine vapour by MacKinnon and Robertson (NATURE, July 13, 1929), appear to be very similar to the forms of discharge observed by us under certain conditions in argon which was very slightly impure. A very brief account was given by W. T. Perry (Note . B.Sc. Thesis, Oxford, 1928), but as this account is somewhat inaccessible, it may be of interest to describe some of the properties of these discharges. Recently, P. Johnson has observed the same type of discharge under similar conditions in neon.

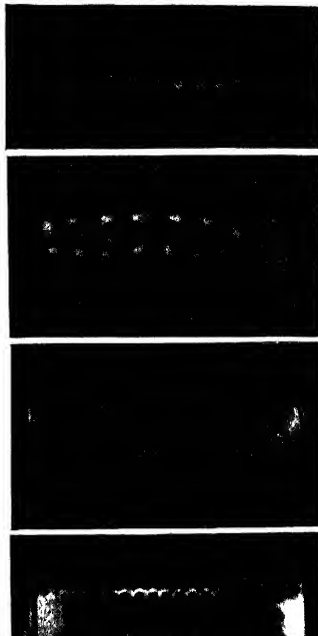
The conditions under which these discharges occur appear to be the following. They occur in neon and argon only when the gas is very slightly impure, and especially when the trace of impurity is a metallic vapour In carefully purified inert gases we have never observed any striations other than the types described by us in NATURE (Jan. 12, 1929). The pressure of the gas must be fairly high and the current flowing through the tube must be large—of the order of 20 milliamperes. They occur, with continuous wave oscillations, at all the wave-lengths we have tried from 11 metres to 320 metres, in tubes from 0 5 to 4 cm. in diameter, and at pressures from 2 mm. to 20 mm of mercury.

Some idea of the structure of these discharges may be gathered from a study of the photographs reproduced in Fig. 1 A, B, C, D, which show typical forms the discharge may assume in a tube 3 cm. in diameter containing argon at a pressure of 7 mm. of mercury. The oscillatory potential of a frequency corresponding to 11 metres was applied by two external wire electrodes wrapped round the tube about 10 cm. apart, and the changes were produced by altering the potential between the electrodes.

With small currents there is a diffuse general luminosity filling the whole tube between the electrodes and some distance beyond them. As the current is increased there is a sudden change to the form of Fig. 1 A, where the luminosity is wholly confined to the line of luminous spheres. The size of the spheres seems to be almost independent of the diameter of the tube and inversely proportional to the pressure of the gas. Unlike the striations in the positive column, they are little affected by a strong magnet.

Further increase in current imparts a motion to the line of spheres which begins to move toward one electrode and around the axis, giving the line a helical form, and generally other lines of discharge appear (Fig. 1 B and C).

With larger currents more lines of discharge appear, the luminosity being entirely on the outside, the axial region being comparatively dark The pattern is then very symmetrical, the lines of the discharge at high pressures being very close together and comprising ten or more parallel helices (Fig. 1 D). If this discharge be viewed with a spectroscope, the lines of



A

B

C

D

FIG 1

impurity appear to have become more prominent, in comparison with the argon lines, and sometimes the discharge is coloured with momentary flashes of light characteristic of them.

This type of discharge has not been observed by us in hydrogen, nitrogen, or air, possibly because it is difficult to maintain a discharge in these gases at a pressure greater than one millimetre of mercury with continuous waves. It would be interesting to know the conditions of wave-length, pressure, and current in the experiments of Messrs. Ghosh and Chatterjee.

What precisely is the mechanism of these discharges is very difficult to determine. It seems probable that the form is in some way connected with the distribution of the more easily ionised impurities which would be expelled by the space charge to the outer parts of the tube. The discharge takes two or three seconds

usually to settle down to a definite form, and this would support such a suggestion

*Note.*—Spiral forms of discharge in ordinary vacuum tubes using direct currents appear among the many observed by de la Rue and Muller so early as 1877 (*Phil. Trans*). They also noted the prominence of the mercury lines in such a discharge Gassiot (*Phil. Trans.*, 1858) also makes mention of a spiral discharge

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## Mode of Feeding of the Bopyridæ.

IN connexion with a study which I am about to publish on the effects of one of the Bopyrid isopods, *Gyge branchialis*, on its host, *Upogebia littoralis*, I have become interested in certain questions concerned with the mode of feeding of the Bopyridæ which seem to have been neglected by students of these animals and to which I wish to direct attention.

It may be recalled that the Bopyridæ are parasitic in the branchial cavity of decapod crustaceans, and that they normally occur in pairs, a large female individual and a minute and less highly modified male, which leads a sedentary existence on the body of the female The latter, at any rate, obviously feeds by sucking the juices of the host by means of its piercing and suctorial mouth-parts, but from what part it sucks them appears, if one looks critically into the literature, to be by no means clear. The animals are often spoken of as though they suck the juices directly from the thorax of the host. Such an eminent authority as Bonnier, in his monograph on the Bopyrids (*Travaux de la Station Zoologique de Wimereux*, tome 8; 1900), seems clearly to imply this, for he speaks definitely (p 50) of the animal sucking "les liquides viscéraux", and again (p. 104), "les liquides de la cavité viscérale de l'hôte". Yet when one reflects that the ventral surface of the parasite, on which the mouth-parts open, is turned towards the branchiostegite of the host and away from the latter's body, these statements appear difficult to accept literally. It would seem that the only way in which the animal could suck "the liquids of the visceral cavity of the host" would be for it to protrude its mouth-parts for a relatively great distance, and at the same time to twist them round to an extraordinary extent, so as to drive them into the host's body, from which they are normally turned *away*. The conformation of the mouth-parts does not suggest that such a proceeding is possible.

The only alternative seems to be to suppose that the animal sucks the juices from the inner membrane of the branchiostegite So far as I know, however, this is nowhere definitely suggested in the literature, though Dr. Calman, to whom I have appealed, tells me that he has always supposed that this is what happens The membrane is certainly often quite well vascularised, though sometimes, as in the *Upogebia* upon which I have been working, it is so thin that one would not suppose it to be a very satisfactory source of nourishment for a suctorial parasite. It appears to me that, unless I have overlooked some important contribution to the subject, no one has really demonstrated clearly and definitely from what part of the host the parasite does extract its food, a curious omission in a group of animals which have received a very fair amount of attention

This is not all · there are difficulties also in connexion with the male. The larval form which first invades the branchial cavity of the host develops into the large female form. Afterwards another arrives, settles down on the body of the first and becomes a male There are two, probably related, questions concerning this second animal to which I can find no clear answers, namely . How does it feed? What causes it to become a male? Apparently the larvæ are equipotential with regard to sex If No. 2 did not feed at all, the difference in its subsequent development as compared with No 1 would be accounted for But the mouth-parts are perfectly well developed like those of the other sex, and some of Bonnier's remarks certainly seem to imply that it does feed But neither Bonnier nor anyone else, so far as I know, explains how a minute animal leading a sedentary existence on the female's ventral surface, which is turned towards the branchiostegite of the host, contrives to reach the host's body with its mouth-parts. Hypothetical acrobatics by which it might manage to do so might be suggested, but I will not waste space on these The point is that if it really does so, it is worth while taking the trouble to find out how

If the male does not suck the host's juices directly, and yet does feed, the only alternative is to suppose that it sucks the juices from its own female Should this prove to be the case it would be surprising that so interesting and remarkable a state of things should not have been noted before, but personally I do not think it is very likely On the whole, it rather looks as though the male does not feed, but if it can be shown that it does not, other questions are raised. Is it possible that it can exist entirely without food for so long as the female, which feeds vigorously and the life span of which is apparently coincident with that of the host? Or is there a succession of males during the lifetime of one female? (I may say that I have examined many *Gyge* and never found an adult female without a male) If the male does not feed, why are its mouth-parts and gut so well-developed? Is it, speaking teleologically, so that it can start feeding and develop into a female if the original female dies? I could add other questions.

What I have said will have been sufficient to suggest that present knowledge of the biology of the Bopyridæ is scarcely commensurate with the knowledge of their structure The points I have raised ought not to be beyond the ingenuity of someone having access to living material to settle I hope I may have an opportunity of doing something in this direction myself at some future time But my immediate object is to inquire whether there is no zoologist who can now from experience already obtained throw some light on these questions, which seem so obvious and yet seem to be carefully avoided or slurred over in all the literature with which I am acquainted.

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## Behaviour of the Mercury Line 1849 57 ($1^1S_0 - 2^1P_1$).

UTILISING an arrangement which permits working in an atmosphere of nitrogen and a Hilger quartz spectrograph model E/37 with Schumann plates (see details in *Contrib Estd. Ciencias Fis. Mat. Serie matemáticofísica*, 4, 102, 1927, La Plata) we have investigated the persistence of the mercury line 1849·57. In the spark spectrum, using Gramont's fulgurator with solutions of mercury salts, $Hg(CN)_2$ or $Hg(NO_3)_2$, it is only possible to register photographically the mercury line 1849 57 when working in an atmosphere of nitrogen (Fig. 1). In the arc spectrum, using McLennan's vacuum arc lamp and operating in a normal atmosphere, and in a nitrogen

atmosphere, using carbon electrodes impregnated with the same mercury salts, the experimental results are strictly the same. These facts support the objection formulated by Gerlach (*Phys. Berichte*, **10**, 429; 1929) with regard to my note published in *Comptes rendus* (**187**, 761; 1928). Operating in the conditions above described and with progressively diluted

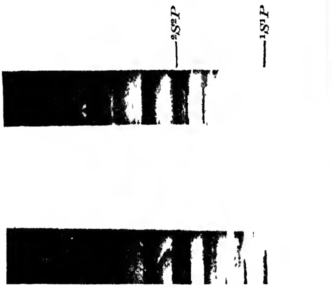

FIG 1.—1, Spectrogram using normal atmosphere; 2, spectrogram using nitrogen atmosphere.

solutions of mercury salts, the persistence of the lines 2536.52 ($^1S^3P$) and 1942.0 ($^2S^2P$, $Hg^+$) is much greater, in all conditions, than that of 1849.57. The latter line is a theoretical but not an experimental 'raie ultime'; the true 'raies ultimes' of Hg are, in all conditions, 2536.52 and 1942.0. For this reason we consider that Meggers is mistaken in supposing ("Critical Tables", **5**, 323) that the line 1849.57 is the most persistent.

ADOLFO T. WILLIAMS.

Instituto de Fisica,
Universidad de La Plata,
R. Argentina, Nov. 12.

## Scattering of Electrons by Gold.

A METHOD has been developed by Born by which the scattering of electrons by single atoms can be worked out on the wave mechanics. The method has been used to calculate the variation of elastic scattering with angle for helium, using the atomic fields worked out by Hartree, and fair agreement is obtained with the experiments of Dymond on the scattering in helium gas (NATURE, May 11, 1929; *Proc. Camb. Phil. Soc.*, **25**, p. 304).

The theoretical formula for the scattering can be put in the following form. The proportion of a beam of electrons scattered elastically per unit length of the beam, per unit solid angle, by a gas containing $n$ atoms per unit volume, is $n\,|f(\theta)|^2$ where $f(\theta)$ is $\frac{e^2}{2mv^2}(N-F)$ $\operatorname{cosec}^2\theta$. $N$ is the atomic number of the scattering atom, $2\theta$ the angle of scattering, and $F$ the atomic scattering factor familiar in X-ray diffraction, calculated from the Schrodinger charge distribution. $F$ is a function of $\sin\theta/\lambda$, where $\lambda$ is the de Broglie wave-length of the electrons. The corresponding formula for the scattering of X rays by an atom is $\frac{e^2}{mc^2}F$ for plane polarised waves, in the plane perpendicular to the electric vector. The close resemblance between these two expressions can be accounted for as follows. In calculating the scattering of X rays we assume that each element of charge $d\rho$ in the atom scatters a spherical wavelet of amplitude, $e^2 d\rho/mc^2r^2$, according to the classical formula of J. J. Thomson. The total scattering is obtained by considering the interference of these wavelets. We may suppose, analogously, for de Broglie waves that each element of charge in the atom scatters a spherical wavelet of amplitude $\frac{ed\rho}{2mv^2}\operatorname{cosec}^2\theta$. We should expect this according to the theory of inverse square law scattering, if the element of charge were held rigidly at rest; presumably, in a collision when this is not the case, the atom is excited. The nucleus also scatters a wave of amplitude $-\frac{Ne^2}{2mv^2}\operatorname{cosec}^2\theta$, the negative sign meaning opposite phase. A consideration of the interference of these waves leads to the formula given above. It will be noticed that the scattering is a function of $\sin\theta/\lambda$.

G. P. Thomson has recently published a curve for gold, deduced from his experiments on the diffraction of cathode rays by thin foils. The curve in Fig. 1 gives

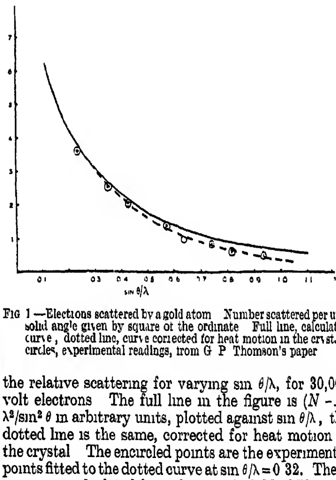

FIG 1.—Electrons scattered by a gold atom. Number scattered per unit solid angle given by square of the ordinate. Full line, calculated curve; dotted line, curve corrected for heat motion in the crystal; circles, experimental readings, from G. P. Thomson's paper.

the relative scattering for varying $\sin\theta/\lambda$, for 30,000 volt electrons. The full line in the figure is $(N-F)$ $\lambda^2/\sin^2\theta$ in arbitrary units, plotted against $\sin\theta/\lambda$, the dotted line is the same, corrected for heat motion in the crystal. The encircled points are the experimental points fitted to the dotted curve at $\sin\theta/\lambda = 0.32$. The $F$ curve was calculated from the atomic field of Thomas, which for heavy atoms has been found sufficiently accurate in the X-ray case.

N. F. MOTT.

Physics Laboratories,
University of Manchester.

## A Theory of Tracheal Respiration in Insects.

IT has been shown by Krogh (*Arch. f. Ges. Physiol.*, vol. 179; 1920) that the laws of diffusion of gases will explain the supply to the tissues of insects of those quantities of oxygen which they actually consume. This theory is satisfactory so far as it goes, but it makes no provision for such increased demands for oxygen as must arise locally in active tissues. It is the purpose of this letter to outline a theory, complementary to that of Krogh, which will satisfy these requirements, and to indicate the experimental evidence by which this theory is supported.

If it be assumed that the terminal portions of the tracheal tubes are bounded by a membrane which is semipermeable with respect to lactic acid and similar metabolites, then, during normal conditions of rest, liquid will be drawn from the tissues up the tracheal tube by capillarity until its progress is arrested by the osmotic pressure of the tissue fluids. During increased activity of the tissues, lactic acid will be

produced, and the osmotic pressure will rise. Hence liquid will be absorbed from the tube, and the column of air will extend more deeply into the tissues. Moreover, this change will take place first in those regions where the need for oxygen is greatest.

This theory is based chiefly upon experiments with the larva of the mosquito, a detailed account of which will be published shortly. Briefly, it has been found (i) That in the resting condition the terminal portions of the tracheal tubes are filled with liquid; (ii) that during asphyxiation this liquid is absorbed, and the column of air extends rapidly towards the actively contracting muscles—more slowly and much later towards inactive tissues (for example, the rectal gills); (iii) that on readmission of air the level of liquid slowly rises to its original level; (iv) that during asphyxiation an excess of lactic acid is present in the tissue fluids; (v) that hypertonic solutions of sodium chloride and of sodium lactate introduced into the living larva cause a similar extension of air down the tracheal tubes; (vi) that hypotonic fluids (distilled water) are without effect, or cause a slight rise of the liquid in the tracheæ.

It is clear that the mechanism described will serve as a 'fine adjustment' for tracheal respiration in insects, just as changes in the capillary bed serve as a 'fine adjustment' for the internal respiration of vertebrates. V. B. WIGGLESWORTH.

London School of Hygiene and
Tropical Medicine, Dec. 5

## Chemical Biogenesis and the Development of Secretion Cells.

DR. LEEMANN's interesting letter (NATURE, Dec. 21, p. 946) emphasises once more the gains which are bound to accrue from an increasing correlation between organic chemistry, biochemistry, and certain branches of purely biological science. As one who was privileged to obtain a first hand acquaintance with the classical phyto-chemical researches of R. T. Baker and H. G. Smith on the Australian flora, I am of opinion that such correlation is often realised most effectively by active collaboration between investigators in the related fields. Thus, it may be justly asserted that collaboration between the histologist and the organic chemist has now become desirable in attacking the engrossing problem of chemical biogenesis (that is, chemical origin *in vivo*) in the terpene series. Nevertheless, one would hesitate to endorse Dr. Leemann's sweeping dictum that the study of such problems "should *only* [my italics] be done in close connexion with cytology and cell development". The purely organic chemical aspect of the subject must not be dismissed too lightly. At the present day, after researches extending over half a century, the study *in vitro* even of such familiar and fundamentally important substances as menthol and menthone is regrettably incomplete. Moreover, of how many essential oils can it be claimed that our formal chemical knowledge is full and adequate?

There is little doubt that a knowledge of the precise cytological origin of the terpenes would be a valuable aid in deciding whether they are derived from carbohydrates (cf. Stewart, "Recent Advances in Organic Chemistry", 1927, vol. 2, pp. 240 and 266), or from protoplasm via amino-acids. Dr. Leemann's suggestion that they originate from protoplasm, rather than from the cell wall, appears to accord with the histological occurrence of fixed oils; while from the chemical point of view leucine offers an attractive approach to the fundamental structural unit (*iso*pentane nucleus) of terpene molecules. JOHN READ.

The University, St. Andrews.

## Hydrolytic Adsorption at Colloid Surfaces.

THE outstanding work on hydrolytic adsorption has been carried out with purified charcoal (see, for example, Bartell and Miller, *J. Am. Chem. Soc.*, **44**, 1866, 1922; **45**, 1106, 1923), and definite positive results have been obtained. The measure of the hydrolytic effect in the case of the numerous negative hydrophobic (acidoid) sols, such as colloidal mastic, platinum, gold, arsenious sulphide, etc.—all of which are remarkably alike in structure and in reactions—is complicated by the well-established phenomenon of catalytic interchange. For example, in the presence of salts, such as barium chloride, the hydrogen ion at the colloid surface suffers an interchange with the added barium ion, and the corresponding increase in acidity is superimposed upon any change in acidity due to the hydrolytic action at the surface. It has become the general practice to ascribe the whole of the increase in acidity of acidoid sols (on the addition of neutral salts) solely to the cationic replacement, and to neglect any probable hydrolytic effect. That the latter effect is real is evident from the following consideration.

Colloidal platinum has a great affinity for bases, particularly bases of higher valence such as barium hydroxide, and no measurable affinity for the common inorganic acids such as hydrochloric acid (*J.C.S.* 551, 1928; 618, 623; 1929). This action I have ascribed to the acidic nature of the oxidised platinum which constitutes the greater part of the colloidal platinum surface. It follows from obvious chemical principles, that when a salt such as barium chloride is added to a platinum sol, the barium hydroxide must distribute itself between the hydrochloric acid and the 'acid' surface of the colloid, or in the usual terminology, barium hydroxide must be hydrolytically adsorbed by the platinum. The hydrochloric acid is, of course, a very strong acid, but the affinity of the platinum surface for barium hydroxide has also been shown to be very great. Work recently carried out by me, and to be published in due course, shows clearly that in the case of colloidal platinum (1) such a distribution does take place, (2) its effect is not negligible when compared with the cationic interchange, and (3) it plays an important part in coagulation and reversal phenomena. The same conclusions will probably apply, in varying degree, to the other acidoid sols.

S. W. PENNYCUICK.

Adelaide, South Australia,
Nov. 5.

## The "Encyclopædia Britannica".

As a contributor to the new edition of the "Encyclopædia Britannica", may I beg the hospitality of the columns of NATURE in order to disclaim responsibility for certain statements that appear in one of the articles over my initials? In the article "Acanthocephala" the short passage commencing with the words "the larva of *Echinorhynchus gigas* . . ." and ending at ". . . found in the seal" is not mine.

I should like to add that the editor of the "Encyclopædia", with whom I have been in communication, has expressed his sincere regret at the unfortunate interpolation, which appears to have occurred in some way during the final making-up of the page, and has undertaken to delete it in future printings of the edition.

H. A. BAYLIS.

British Museum (Natural History),
Cromwell Road, London, S.W.7,
Dec. 17.

# Past Climates.

By Dr. G. C SIMPSON, C B, F.R S

THERE are only three factors which can affect the climatic zones of the world (*a*) the amount of solar radiation, (*b*) the horizontal transfer of heat from one part of the earth to another, and (*c*) the characteristics of terrestrial radiation. If we examine each of these factors, we find that terrestrial radiation is not affected by the amount of carbon dioxide in the atmosphere, and, while dust might affect it, there is no real evidence that changes in climate are correlated with volcanic activity. The horizontal transfer of heat could only be affected by changes in oceanic currents due to a redistribution of land and water, but a comparison of the temperature of corresponding zones in the northern and southern hemispheres shows that a climatic zone is little affected by the amount of land and sea which it contains. Small changes in solar radiation may produce appreciable effects on the climate, and a theoretical investigation shows that an increase in solar radiation is accompanied by:

(*a*) an increase in temperature in all parts of the world;

(*b*) an increase in the temperature difference between the equator and the poles, and probably an increase in all other temperature differences which now exist,

(*c*) an increase in the general circulation of the atmosphere, that is, a general strengthening of the trade winds, the monsoons, cyclonic storms, and winds in general,

(*d*) an increase in the cloud amount and a consequent increase in all forms of precipitation.

## THE LATE PALÆOZOIC GLACIATION

The geological evidence is quite conclusive that during Upper Carboniferous or early Permian times, great ice action took place in many localities, especially in the southern hemisphere South America, Africa, India, and Australia all exhibit unmistakable evidence of ice action which is far too extensive to be mere Alpine glaciation. In India especially, the evidence is conclusive that the ice sheet extended to sea-level I think all geologists are agreed that at this period extensive ice sheets occurred within the present tropics in South America, Africa, and India, and at one place at least on the present equator

Let us assume for a moment that we may accept this evidence at its face value and see what it would mean. Ice at numerous places in a zone of latitude indicates a mean annual temperature characteristic at present of polar regions. Thus at the time in question the present tropical zone had the conditions of the present frigid zone, and this could not possibly be brought about by any re-arrangement of land and water

If the change in climate was not the consequence of a redistribution of land and water, was it due to a radical change in solar radiation? Let us assume that the solar radiation decreased until the mean temperature of the equatorial zone was 0° C, which is approximately the present temperature of latitude 60°. I have already shown that the zonal temperature must decrease in all circumstances from the equator to the poles, hence every other zone of the earth must have had then a mean temperature below 0° C, which simply means that every part of the earth's surface would have been subject to conditions now met with only in polar regions. The glacial conditions of the equator would extend over both hemispheres with increasing severity right to the poles These conditions could not have occurred without a total obliteration of the organic life which was already highly developed in Carboniferous times A change in solar radiation does not therefore afford a solution of the problem.

I have noticed a tendency amongst geologists in discussing the climate of this period to assume that the climatic conditions could be very different in the two hemispheres. A picture is drawn of a great continent in the southern hemisphere, highly glaciated and sending out glaciers and ice sheets right across the equator into the northern hemisphere, while at the same time farther north there were lands covered by the luxuriant vegetation typical of the Carboniferous period.

Not only does this picture violate our conclusion that the climatic zones in the two hemispheres are always similar, but also it gives an inverted temperature gradient with the temperature rising from the ice-bound tropics to the region of rank vegetation in higher northern latitudes. To me, at least, an ice-bound tropics with rank vegetation in higher latitudes is a physical impossibility, and I can see no explanation of such a situation along meteorological lines. If, as I am prepared to admit, there was at one time ice in the present tropical zone and simultaneously sub-tropical vegetation in the present temperate zone, then I am forced to conclude that Wegener is right and there has been a considerable shift of the continents relative to the pole and the climatic zones

## THE PLEISTOCENE ICE AGE.

I will now turn to a changed climate of a more recent date, namely, that of the last great Ice Age I do not propose to discuss the extent of surface affected by this Ice Age or the low latitude to which the ice extended. Personally, I am convinced that Wegener is right in displacing the north pole and shifting the North American continent nearer to Europe; only by some such means can the excentric position of the glaciated region with reference to the present position of the pole be explained.

However, let that be as it may, there is another

[1] Abridged from the Alexander Pedler Lecture of the British Science Guild, delivered before the Literary and Philosophical Society of Manchester on Nov. 26.

feature of the Ice Age which is of much more interest to a meteorologist than is the occurrence of several interglacial periods during the period covered by the Ice Age. In these periods there is good evidence that, even if the ice did not entirely disappear, there was a great contraction in the ice-covered area and that temperature conditions in some of the interglacial periods were as mild, if not milder, than they are to-day. Now neither Wegener nor any geologist, so far as I know, has suggested that these interglacial periods were brought about by changes in the physical features of the earth's surface. It is inconceivable that the pole could have wandered away and returned during the relatively short interval of an interglacial period, and there is no evidence of rapid changes in the distribution of land and sea during the interglacial periods. Hence we are thrown back on to changes of solar radiation as the only possible cause. We are therefore led to examine what would be the effect on a polar climate of changes in solar radiation.

To fix our attention, we will consider what would be the effect of a change in solar radiation on a region which at present is glaciated because the summer temperature is below the freezing-point.

We will first examine the consequence of a reduction in the solar radiation. We have already seen that the temperature in all latitudes falls when the solar radiation decreases; therefore the mean temperature at our station will also fall. We also saw that a decrease in solar radiation results in less cloud and precipitation. In our case the precipitation decreases for two reasons: first, the air carries less moisture because the temperature is low; and secondly, less moisture is carried to the station because the general circulation of the atmosphere has decreased. Thus the net result of the decrease in the solar radiation is a lower mean temperature and less snowfall. In consequence, the thickness of the ice covering would decrease, and if the reduction proceeded far enough, large areas might even become free from snow.

If the solar radiation increased, we should have a reverse effect. The mean temperature would rise and the precipitation increase, and the result would be an increase in the thickness of the snow covering and all glaciers would increase in thickness and length.

In a recent paper, Meinardus has discussed a similar problem from an entirely different point of view. Starting from the observed fact that the ice covering in the antarctic was once much thicker than at present, probably two or three times as thick, Meinardus discusses all the factors which could have affected the snow covering, and reaches the conclusion that the former thickness of the ice can only be explained by a higher temperature accompanied by an increase in the general circulation of the atmosphere. He calculates that for the outflow of the ice from the present antarctic continent to have been three times as great as at present, the mean temperature must have been 4° C. higher and the circulation doubled.

This is strong independent support of the conclusion that an increase of solar radiation would increase the glaciation of the region we are considering. This, however, would only be the initial effect of increasing the radiation; if the increase progresses, there will come a time when the increased temperature produces melting in the summer. From this point on, melting becomes more and more important, until finally the annual

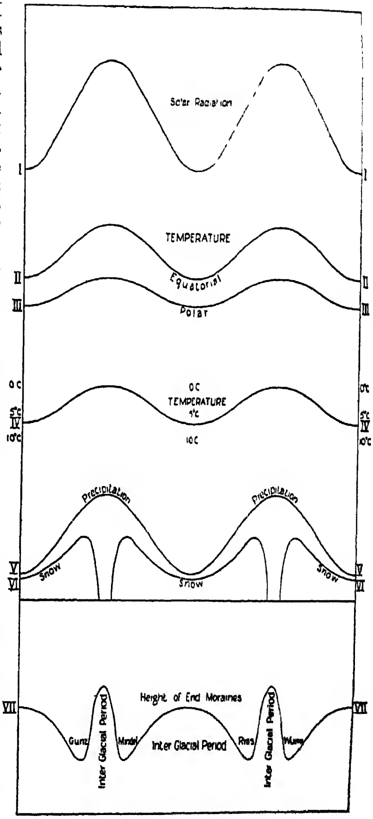


FIG. 1.—Effect of two cycles of solar radiation on glaciation.

melting might be as great as the annual snowfall, when the ice covering would disappear. This comes about in two ways: (1) the period of snowfall would be reduced owing to the raising of the mean annual temperature, and (2) the summer melting would be increased in intensity and continue for a longer period.

It appears to me that these considerations give us a possible clue to the meteorological conditions during the great ice ages in the Pleistocene Period.

We have already seen that changes in solar radiation can produce changes which materially

alter the amount of glaciation, and obviously the next step is to follow through the whole sequence of changes which would result from one or more complete cycles of change in solar radiation To do this I have prepared a diagram based on two cycles of solar change In Fig 1 the abscissæ represent time, but no scale of years is attached as we have at present no clue to the absolute time involved. it is sufficient to say that we are dealing with a unit of a thousand years rather than with a unit of years. Curve I represents two complete cycles of solar radiation The variation of radiation only is represented, but what proportion this variation has to the total radiation it is impossible to say, nor is it necessary to inquire at this stage. The variation in solar radiation produces a change in temperature, the change being larger at the equator than at the pole · this is represented by Curves II and III, which show the relative changes in temperature in equatorial and polar regions respectively.

In order to follow the effect of these changes, it is necessary to fix our attention on some definite regions, for it is clear that the effect will vary greatly from latitude to latitude. Let us choose a place which has a mean annual temperature of 0° C. during the warmest epoch We have no idea of the magnitude of the temperature oscillation at such a place, but we will assume that it is about 7° C Curve IV has been drawn to represent a temperature oscillation of this amount, as shown on the scale of degrees attached. It is clear from what has already been said, and also from Curves II and III, that periods of maximum radiation are accompanied by increased difference of temperature between equatorial and polar regions, the consequence being greater general circulation of the atmosphere, more cloud and more precipitation, if not in all latitudes at least in equatorial and polar regions Thus there would be variations in precipitation in our region in step with the changes of solar radiation and temperature This is shown diagrammatically in Curve V, which, however, is not drawn to any scale, so that the absolute value of the oscillations is not indicated on the diagram.

At the epoch of minimum temperature—the extreme left of the diagram—the mean annual temperature is $-7°$ C.; by hypothesis, therefore, the summer temperature will probably rise to the freezing-point and there will be a certain amount of melting Curve VI, which represents the annual accumulation of snow, therefore starts somewhat below the curve of precipitation With the increase of temperature the proportion of the total precipitation which remains as snow decreases, and when the mean annual temperature, as shown on Curve IV, approaches the freezing-point, the melting exceeds the snowfall and there is no residual snow to accumulate Thus the accumulation of snow increases from the epoch of minimum radiation, until a point is reached beyond which the continued rise in the radiation produces a rapid diminution in the snow accumulation, which in the particular conditions we are discussing entirely disappears at the epoch of maximum radiation As the radiation decreases from its maximum, the same changes take place in the reverse order

The significance of these changes is best realised by considering that the locality we are investigating is a mountainous region In this case the snow which accumulates year by year flows off the mountains through glaciers The thickness and length of a glacier depend much more on the amount of snow which accumulates than on the temperature of the region into which it flows Thus each glacier will descend far down the mountainside during each period of accumulation, and this is shown by Curve VIII, which represents the height on the mountain slopes where the end moraines of the glaciers would be met with at each period. This diagram shows us that with the two periods of solar radiation we should have had four distinct advances and retreats of the glaciers and that the advances occur in pairs, the interval between two pairs being considerably greater than the interval between the members of each pair

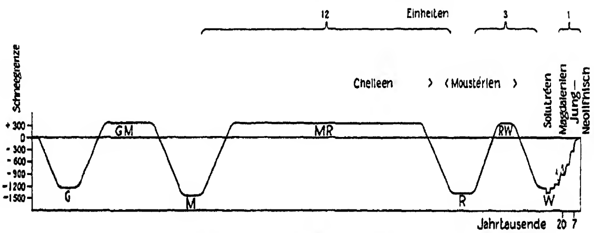


FIG 2—Penck and Brückner's diagram of the succession of ice ages in the Alps The abscissæ are time and the ordinates the height of the snowline.

Now there can be no doubt that during the great Ice Age the glaciers of the Alps did advance and retreat just in the manner here described. This is best shown by reproducing a diagram prepared by A Penck and E Bruckner to illustrate the conclusions of their great investigation of the glaciers of the Alps during the Ice Age (Fig 2). The similarity between this diagram and my Curve VIII is unmistakable, and I feel justified in adding to my diagram the names Gunz, Mindel, Riss, and Wurm to the four maxima of glaciation and to describe the intervals between them as interglacial periods.

So far, we have considered only the conditions

in or near the polar regions where glaciation is the predominating evidence of change of climate What changes should we expect to see in other regions of the world? Changes of temperature are difficult to recognise geologically, except in polar or desert regions, but changing precipitation leaves a very clear record in the strand lines of lakes and inland seas Now it is generally recognised that during the ice age there were great variations in the levels of lakes, so much so that the term pluvial periods has been introduced to specify these periods Is there any relationship between these pluvial periods and the ice ages? In the 'Great Basin' in North America there is clear evidence of the pluvial periods According to Gilbert and Russell, both Lake Bonneville and Lake Lahontan show two periods of high level between which both lakes were completely dried out and desiccated They also found clear evidence of glaciers entering the enlarged lakes, showing that one at least of the maximum epochs of the lakes coincided with one of the North American ice ages The pluvial periods have also left clear traces in equatorial Africa, and here again the evidence points to two main pluvial periods, the first of which, according to Wayland (see NATURE, Aug 17, 1929, p 279), corresponds to the Gunz-Mindel Ice Age and the second to the Riss-Wurm Ice Age Thus in both North America and in Africa there have been during the Pleistocene Period two main pluvial periods, while in polar regions there have been four ice ages

Whether the theory of the cause of the interglacial periods which I have sketched here will prove to be correct or not can only be determined after years of research, and, in discussing it, account must be taken of possible movements of land masses and possible shifts of the poles I do not propose to go into any further details here, but will simply direct attention to several consequences of the theory which should be touchstones for testing it

(a) The four glacial ages occurred during periods of relatively high temperature in all parts of the world

(b) There are two kinds of interglacial periods (1) warm interglacial periods which occur between the two members of each pair of glacial periods; (2) cold interglacial periods corresponding to the interval between the occurrence of the pairs of glacial periods

(c) Each pair of glacial periods, with the intervening warm interglacial period, coincides with a pluvial period in unglaciated regions.

### RECENT CHANGES IN CLIMATE

There has been much controversy regarding climatic changes in historical times It is impossible for me to go into the details of this controversy, but I think I may fairly sum up the discussion by saying that there is little evidence for any appreciable change in temperature, but that there is quite a mass of evidence for moderate changes in the amount of rainfall It is clear that the historical period is much too short to show any appreciable part of the large but slow changes which give rise to the main changes of climate shown in the geological record and of which the ice age is the last example These changes probably required 20 or 30 per cent in the change of solar radiation Any change in the historical period must have been of the order of only a few per cent, and probably took the form of minor fluctuations on a more general change

Now I have tried to show that the effect of changes in solar radiation are chiefly counterbalanced by a change in the general circulation of the atmosphere and increased cloud and precipitation rather than by large changes in the temperature It is not surprising, therefore, that what fluctuations there have been are shown chiefly by fluctuations in rainfall, the best evidence of which is seen in the changed level of lakes without efflux, the changed boundaries of deserts, and the relics of old cultivation in places where now cultivation is impossible

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## Dog Distemper and Immunisation.

By P P. LAIDLAW, F.R S.

SOME seven years ago the *Field* Distemper Fund was inaugurated with the object of encouraging the study of dog distemper, in the hope that the ravages of this disorder might be mitigated through the discovery of some preventive measure or some satisfactory method of treatment The *Field* Distemper Council, which body administers the *Field* Distemper Fund, joined forces with the Medical Research Council for the purpose of this study, and a scientific committee, composed of veterinary and medical men, was formed to supervise the research work The Medical Research Council is interested in dog distemper as it is an example of an acute infectious fever, comparable in many respects to such diseases as influenza or measles in man, and it was hoped that the study of the canine fever would ultimately lead to a better understanding of such infectious fevers in man.

The highly infectious nature of distemper rendered the study somewhat difficult, for it was necessary to take elaborate precautions throughout the investigation in order to guard against accidental spread of the disease. New buildings were constructed for the work and dogs were bred, in the strictest possible isolation, for the purposes of experiment. Progress was thus inevitably slow, but it is now clear that without the special equipment and in the absence of the rigid precautions against accidental infection, it is highly probable that little progress would have been made.

The demonstration of the fact that ferrets were very susceptible to dog distemper was of great assistance to the work, for it was found to be possible to experiment in the first instance with this species which is relatively easy to maintain in close confinement and strict isolation, and reserve the specially

bred dogs for crucial experiments The facts disclosed in the study of the disease in ferrets have been shown to be applicable to the disease in dogs with only minor modifications

At the time the work for the *Field* Fund was commenced, the nature of the infectious agent in dog distemper was not firmly established Carré, in 1905, came to the conclusion that the disease was caused by a filterable virus He quoted experiments to show that the contagium would pass through the pores of filters specially designed to hold back all ordinary bacteria, and he found that the disease could be transmitted with material in which no structures resembling bacteria could be detected under the microscope and from which no bacterial cultures could be secured Carré's view did not meet with general acceptance, and from time to time various visible bacteria, which were regarded as causal organisms, were secured from distemper cases That infection with ordinary bacteria did occur very frequently in distemper cases was undoubted, but it was by no means clear which of the several bacteria recovered from diseased animals should be regarded as the primary cause of the disorder and which the secondary, or if, under the view put forward by Carré, all the visible bacteria were really secondary infective agents and the true contagium was an ultramicroscopic virus

The workers for the *Field* Fund confirmed Carré's findings in all essential particulars and showed that the disease could be transmitted, at will, by the blood and tissues of distemper cases through an indefinite series of animals. The infective material appeared to be sterile in all the usual laboratory culture media and no bacteria could be demonstrated by microscopic examination. Further, the infective principle was shown to pass through bacterial filters of standard type and proven quality. It thus seems established that dog distemper is primarily a virus disease and that all the bacteria which can be recovered from distemper cases are really secondary invaders of damaged tissue. It was further obvious that preventive measures should be directed against the virus infection in the hope that, if this could be eliminated, the secondary invading organisms would be deprived of their aggressive ally and rendered almost, if not quite, impotent

It was found that distemper virus could be inactivated or killed in a number of different ways and that, provided the treatment to which the virus was submitted was not too drastic, the inactivated virus formed an efficient vaccine That is to say, a large dose of inactivated virus could be injected into an animal with complete impunity and, after the lapse of some days, the recipient of the vaccine developed a resistance to injections of fresh living virus. Supplies of virus cannot be secured by artificial culture methods, as is the case with ordinary bacteria, and recourse was therefore made to the tissues of distemper animals as a source of crude virus. The lymph glands, spleen, and liver of distemper animals nearly always have a high virus content and they can be converted into an efficient vaccine, without much difficulty, by means of small doses of formaldehyde It was found to be possible to immunise more than 90 per cent of ferrets by giving them a single injection of vaccine made from distemper ferret tissue. Similarly, it was found to be possible to render dogs resistant by means of a single dose of vaccine made from tissues of a distemper dog. The resistant state which develops in a dog or ferret after the injection of vaccine is converted into a solid and durable immunity by the injection of living virus Animals so treated have been given massive doses of distemper virus and they remained unaffected, they have been deliberately placed in contact with severe cases of natural distemper, complicated by secondary infections and without complications, and they have not developed the disease

After the method had been shown to be almost uniformly successful under experimental conditions, the method was extended to the field and several hundreds of foxhounds and other breeds of dogs were first vaccinated and then given a small dose of living virus It was hoped that this procedure would give as solid and as durable an immunity as that which follows a recovery from the natural disorder and yet be comparatively free from risks It was realised that the injection of living virus could never be made absolutely safe, but the immunity which follows recovery from the natural infection, however mild, is so firm and so durable that a final dose of living virus should guarantee real immunity in the vast majority of instances The resistance set up by vaccine alone, though very definite and significant, was scarcely great enough to be called immunity, and it was doubtful if it would, by itself, render a dog immune for life The results of this extended field trial were satisfactory in that the great majority of the hounds and dogs came through the immunisation process with no trouble and afterwards proved to be immune to epizootic distemper, which caused severe illness and even death in their unvaccinated companions In a small percentage of cases the living virus caused a severe reaction in the vaccinated dog, but this was usually of short duration and was followed by complete recovery. In less than one per cent of cases death followed the administration of the virus The production of the prophylactic has now been undertaken by a commercial firm in Great Britain and by another in the United States of America, and several thousand doses have been issued.

It is not possible to pass any final judgment on the method at the present time It is clear that the use of living virus carries with it some risk, for its inoculation causes, even in the vaccinated dog, a considerable strain on bodily health, and unless the recipient is free from all forms of infection grave harm may ensue It is also necessary to remember that the immunisation against the virus disease is no guarantee against infection by bacteria, which may cause bronchitis, pneumonia, gastro-enteritis, and so on, but on the other hand, immunisation should diminish the incidence of these diseases, for it seems clear that the virus frequently weakens the dog's resistance and thus assists bacterial invasion.

Immunisation should prevent, in large measure, the epizootic disease which causes such heavy losses year by year in the canine population

It may be noted here that this vaccination against distemper is merely a special case of protection against a virus disease by means of inactivated or dead virus Very similar results have been recorded recently in other diseases such as rabies, rinderpest, fowl plague, and foot-and-mouth disease In the case of foot-and-mouth disease the matter is complex, for it is now clear that there are at least three strains of virus causing this disorder, and immunity to one strain does not carry with it immunity to either of the others So far as information goes there appears to be only one strain of distemper virus, and a dog or ferret which is solidly immune to a virus from one source is immune to strains from other sources

The study of distemper has not so far proved illuminating as regards the infectious fevers of man Vaccines made from homologous tissues are clearly not available in the case of man, and yet the hope is raised that if only artificial cultures could be secured, we might make from them vaccines which would do much to minimise the disharmonies produced by the infectious fevers

## Obituary.

### PROF CHARLES CHILTON

DR CHARLES CHILTON, whose death on Oct 25 is reported from Christchurch, New Zealand, had a career which was in several respects noteworthy. He overcame a physical handicap that might have excused a somewhat passive attitude to life, and he practised in turn three different professions without failing of success in any of them

Chilton was born at Leominster, Herefordshire, in 1860 and was taken to New Zealand as a child In his boyhood an accident led to the loss of a leg and incapacitated him from following his father's occupation of farming It was on this account that he became a student at Canterbury College, where he studied natural science and came under the influence of Capt Hutton and Sir Julius von Haast, afterwards graduating with honours in zoology. He was a schoolmaster for some fifteen years, first at Christchurch and later at Port Chalmers, where he became headmaster of the High School. He found, however, that the demands of the teaching profession left little opportunity for the pursuit of his favourite studies in zoology, and in 1895, when already approaching middle age, he did what few men would have ventured to do; he resigned his position and came back to Great Britain to enter as a medical student at Edinburgh. His stay in Edinburgh was punctuated with medals and scholarships, and in 1898, after a period as house surgeon in the ophthalmic ward of the Royal Infirmary of that city, he travelled on the Continent, studying diseases of the eye at Heidelberg and Vienna, and returned to Christchurch, where he set up as an ophthalmic surgeon

All this time Chilton had been giving his spare hours to zoology and had published a series of important papers on the Crustacea. When the late Prof Dendy received a year's leave of absence from his chair at Christchurch, it was natural that Chilton should be appointed to take his place. Dendy, however, did not return, for during his absence he received a call to King's College, London, and Chilton became professor of biology in Canterbury College He at once made his mark as a teacher and also as an investigator, although the administrative side of academic life absorbed, as it always does, more and more of the time that should have been given to research In 1921 he was appointed rector of his college, a position which he held until the end of 1927, when he had to resign following a breakdown of health due to overwork Recent letters spoke of his health as completely restored, and his death after a few days' illness of pneumonia was unexpected

Chilton had a high sense of the scientific man's duty to the community in which he lived, and although he never sought municipal honours, he was prominent in the affairs of his city and province, taking the lead in many movements relating especially to education and the public health. He revisited Great Britain in 1912 as one of the representatives of New Zealand at the Congress of Universities of the Empire, renewing old friendships in scientific and medical circles and receiving the honorary degree of LL.D. from the University of Aberdeen A heavy blow fell on him when his only son was killed at Gallipoli.

Living in a country of which the invertebrate fauna is still very imperfectly explored, Chilton took the view that the most immediate need of biological research was the thorough exploration of this fauna and the study of its ecological and geographical relations He early specialised on the Crustacea, and most of his published work refers to this group. In 1891 he published, in the *Records of the Australian Museum*, a paper on "A New and Peculiar Freshwater Isopod from Mount Kosciusko" in New South Wales. This was *Phreatoicus australis*, the first fully described member of a new sub-order now known to contain a considerable number of species in the freshwaters of Australia, Tasmania, and New Zealand. The more recent discovery of a species at the Cape has afforded striking additional evidence of faunal affinity between the South African and Australasian regions. Chilton, as a result of his detailed study of the structure of *Phreatoicus*, pointed out "that the group must be of very considerable antiquity", and thirty-five years later he had the good fortune to confirm his own prediction by describing a fossil *Phreatoicus* from the Triassic rocks of New South Wales

Another subject to which Chilton gave much attention was the fauna, and especially the Crustacea, of subterranean waters. His memoir on the

subterranean Crustacea of New Zealand, published in the *Transactions of the Linnean Society of London* in 1894, revealed the existence of a very peculiar fauna, including a blind species of *Phreatoicus*—which had been briefly described some ten years before—and other forms the affinities and probable origin of which were discussed in detail

In 1907, Chilton took part in an expedition to the sub-antarctic islands of New Zealand, organised by the Philosophical Institute of Canterbury, and he edited the volumes in which the results of the expedition were recorded, as well as contributing the section on Crustacea One of the many enterprises in his later life was the establishment of the mountain biological station of Canterbury College at Cass, originally suggested by Dr L Cockayne, for the investigation of the ecology of the New Zealand Alpine flora and fauna W T C.

BY the death of Prof Naomasa Yamasaki, geographers and seismologists are deprived of an active and very able colleague A notice of his life and work appears in *Proc Tokyo Imp Acad*, vol 5, pp. xviii-xx, 1929 Born on Mar 10, 1870, he was educated in the College of Science in the Imperial University of Tokyo, and in 1899 he was sent by the government to Europe for three years to study geography In 1902, on his return, he was appointed lecturer, and in 1911 the first professor, in geography in the College of Science As a young geologist, he was keenly interested in the eruption of Bandai-san in 1888 and the Mino-Owari earthquake of 1891. Later, he published reports on Yakedate, Miharayama, and other Japanese volcanoes, in which their structures and morphological developments were explained in detail His last work was one, in collaboration with Prof Imamura, on the tilting movement in the blocks of the Fuji volcanic zone bordering the Japan Sea To seismologists, Prof Yamasaki is best known by his valuable memoirs on the physiographical relations of the recent Kwanto, Tajima, and Tango earthquakes During the last year of his life, Yamasaki suffered from heart disease, from which he died on July 26

WE regret to announce the following deaths

Dr. E W. Allen, chief of the office of experimental stations of the U S Department of Agriculture and vice-president in 1920 of Section M of the American Association for the Advancement of Science, on Nov 11, aged sixty-five years.

Prof. Leonard S Austin, metallurgical engineer and chemist, at one time professor in the Michigan College of Mines, on Oct 29, aged eighty three years.

Mr. William Hewitt, formerly director of technical education in Liverpool, who was keenly interested in the regional survey work of the University and in 1922 published a book on the Wirral peninsula, on Nov. 27, aged seventy-eight years

Dr. Frederick Montizambert, C M G , I S O , formerly Director General of Public Health and Sanitary Adviser to the Canadian Government, the doyen of the public health service in Canada, on Nov. 3, aged eighty-six years

The Hon Athelstan John Henton Saw, Chancellor of the University of Western Australia, on Nov 28, aged sixty-one years

## News and Views.

PROF ROBERT ROBINSON, the new Waynflete professor of chemistry in the University of Oxford, may be aptly described as the most brilliant pupil of his illustrious predecessor, the late Prof W H Perkin. His association with Prof Perkin began in Manchester, and he remained in communion with his former teacher throughout an academic Odyssey which led him in turn to chairs in the University of Sydney (1912), Liverpool (1915), St Andrews (1921), Manchester (1922), and London (1928) A long-continued collaboration with Prof. Perkin was directed mainly towards the solution of outstanding problems in the chemistry of alkaloids, and the researches of Perkin and Robinson on narcotine, harmine, harmaline, etc, have become classical. Prominent among Prof Robinson's independent work in this group is a masterly paper, published in 1917, detailing possible ways in which many of the familiar alkaloidal skeletons may be conceived to originate in the plant by means of comparatively simple reactions. The elegant simplicity which is a characteristic feature of Prof. Robinson's synthetic work is illustrated by his production of tropinone through the direct interaction of succindialdehyde, methylamine, and acetone—a veritable 'test-tube reaction' which supplanted a laborious synthesis of some twenty steps.

IN a series of later studies, dealing largely with the structure and synthesis of other plant products, Prof. Robinson has made notable advances in the chemistry of the anthocyanins and related substances, in general, also, his work has thrown much new light on the possible mechanisms of plant metabolism In another direction he has exercised his influence upon the development of industrial organic chemistry in Great Britain; while, among his numerous contributions to pure theory, specific mention may be made of his application of the electronic theory of valency to organic chemistry. His highly original and distinctive work was recognised by the Chemical Society in the award to him of the Longstaff Medal in 1927. It is fortunate that British organic chemistry, at a critical juncture in its development, should be able to provide a master of synthesis, endowed with a profound knowledge and command of natural organic products, to succeed to this important 'key' chair at Oxford.

VERY hearty congratulations will be extended to Prof. Sydney Howard Vines, eminently distinguished in botanical science, who celebrates, on Tuesday next —the last day of the year—his eightieth anniversary of birth A Londoner, he was educated at private schools, graduating in due course at Christ's College, Cambridge. Vines enjoyed the privilege of personal association with Huxley through the courses of instruction in general biology devised by the latter and conducted in the early 'seventies at South Kensington. When an undergraduate of Christ's College, he was

offered an appointment there as demonstrator in the teaching of botany, and fulfilled duty jointly with Thiselton-Dyer and others. Of those early experiences Prof. Vines has recorded that "it was a great, almost oppressive, honour to be introduced to Huxley as one of his junior assistants." Fellow of Christ's College, 1876–88, Vines was University reader in botany, 1883–88, following which he was appointed Sherardian professor of botany in the University of Oxford, retiring in 1919, after thirty-one years' service. He was president of Section K (Botany) at the Bradford meeting of the British Association in 1900, when he gave, in his address, a summary of the position and progress of botany in the nineteenth century. Prof. Vines was president of the Linnean Society, 1900–4, a term of office memorable for the sanction of a supplemental charter enabling the election of women to the fellowship. In 1906 a body of subscribers presented his portrait to the Society, painted by the Hon. John Collier; it hangs in the Society's meeting room at Burlington House.

AN announcement of very great importance to students of ancient man has been made by Prof. Sergio Sergi, of the Anthropological Institute of the University of Rome. He has just published in the *Revista di Antropologia*, vol. 28, p. 3, a preliminary note on the skull of a Neanderthal woman discovered in a pit or quarry situated in the north eastern outskirts of Rome. The pit lies in the valley of the Aniene, a tributary of the Tiber, and exposes deposits of the Quaternary period. Although the culture of Neanderthal man—the Mousterian culture—has been found in many parts of Italy—particularly in the lower valley of the Aniene—hitherto no trace of the fossil remains of Neanderthal man has been discovered. The skull was found embedded in a stratum of gravel which is rich in the remains of pleistocene mammals, including *Elephas antiquus*, *Hippopotamus major*, and *Rhinoceros Merckii*, a fauna indicating a mid-pleistocene date. The geological evidence points definitely to the stratum wherein the skull was found, which at other places has yielded Mousterian implements, as having been laid down in the interglacial period which preceded the last great glaciation—the Riss-Wurm interglacial. From the photographs published in Prof. Sergio Sergi's preliminary note, it can be inferred that the Aniene skull is almost a duplicate of the original Gibraltar skull, with the same cranial capacity of about 1200 c.c. Anthropologists will look forward to the publication of the full account of this skull—one of the most complete specimens ever found. Prof. Sergio Sergi is the son of the distinguished Nestor of anthropologists, Prof. Giuseppe Sergi of Rome.

THE National Institute of Industrial Psychology is making a public appeal for £100,000 to assist in its research and educational work. The Institute was founded in 1921 as a scientific association, and therefore can make no profits. Much of its work is concerned with the carrying out of special investigations in factories on the many problems that arise in connexion with the human side of industry. These investigations are paid for by the firms concerned, but if the Institute's services are to be of the greatest value the scientific basis of its work must be maintained by fundamental research. Moreover, there is an ever-increasing demand for the dissemination of the specialised knowledge the Institute's investigators have acquired by their research and experience. Such educational work cannot be made self-supporting, but unless it is systematically undertaken, much of the knowledge gained by the Institute will fail to be of practical value. The Institute has already received very generous support for its research work from the Carnegie Trustees and the Laura Spelman Rockefeller Memorial, but the time has now come when it must make a wider appeal if its efforts are to be fruitful of the best results. The Institute has made such rapid progress since its inception that there can be little doubt that it fulfils a very real need in national industrial life, but it is clear that its future progress can only be assured if it has adequate funds for research and education.

AN appeal for funds is being made on behalf of the excavations which are now being carried out by Mr. and Mrs. Guy Brunton at Badari in Middle Egypt. The excavations in this area were initiated by the British School of Archæology in Egypt at Qau in 1922, when Mr. Brunton was in charge of the expedition. During the last two seasons the expedition, which since the operations of the School have been withdrawn from Egypt has been working independently, has brought to light remains of the various predynastic cultures, and has discovered the first evidences of the Tasian civilisation, a culture which apparently is the oldest known in the Nile Valley. The Badarian and Tasian cultures have provided us with evidence of agriculture, weaving, and metal working at a date long before these could have been expected. Unfortunately, tomb robbing is particularly prevalent in the area, and unless immediate advantage is taken of the opportunity, scientific investigation will before long be impossible. Up to the present, the expedition has had little support and the expenses have been met privately. As it is not possible to carry on the work indefinitely without assistance, an appeal is now made for subscriptions. The expedition works under the auspices of the British Museum, which receives the greater part of the objects found in so far as these are not retained for the Cairo Museum by the Egyptian authorities. Subscriptions should be sent to the Director of the British Museum.

THE more detailed reports of Col. and Mrs. Lindbergh's archæological survey by air in the south-west United States and Maya area of Central America, which have now been issued by the Carnegie Institution of Washington, suggest that this instrument of research, which has proved its value in the archæology of Britain and the Old World generally, is likely to be of even greater assistance to American archæologists. Two reconnaissances were made by the Lindberghs with the co-operation of the Pan-American Airways and the Carnegie Institution. In the first, several days were spent in flights from the well-known archæological site of Pecos, New Mexico, as base. More than a hundred photographs were taken,

and while flying over the Cañon de Chelly, several hundred miles from Pecos, a number of small ruins were discovered which, though not far distant from one of the archæologists' camps, had not previously been found, or apparently ever visited by a white man On the second expedition, Belize was made the base, and in flights extending over four days the principal Maya sites were visited, some hundreds of miles of impenetrable forest were traversed, and at least four entirely new and unvisited Maya cities were discovered.

FROM these two reconnaissances by air it is evident that the employment of the aeroplane holds out advantages of the greatest moment to American archæologists. It affords a means of rapid transport—transport being one of the greatest difficulties of the archæological explorer, especially in the tropical forest of Mexico. The journey from Tikal to Uaxactun, usually a long day's journey by mule train, was accomplished in six minutes. Further, it can pass over forests practically impenetrable on foot, thus leading to new discoveries and transporting workers to those sites which cannot or at any rate have not yet been reached. Lastly, it will make possible a survey and accurate map, not only of the ruins themselves, but also of the surrounding geographical features which cannot now be observed from the ground. These latter, it need scarcely be pointed out, are of vital import in the attempt which American archæologists are now making to reconstruct the social and economic life of the earlier cultures of the region.

THE most remarkable rains in the British Isles during the past forty years were dealt with by Dr J Glasspoole in a paper entitled "The Areas Covered by Intense and Widespread Falls of Rain", read at the Institution of Civil Engineers on Dec. 17 The engineer dealing with town drainage is concerned mainly with intense rains of at most a few hours' duration, while in the case of large catchment areas prolonged rains lasting, with breaks, as long as a week are likely to be more disastrous. Three variables, therefore, have to be dealt with, namely, rainfall quantities, the duration of rainfall, and the areas covered by these rains. The heaviest orographical rains spend their force on the mountains, giving little rain in the adjacent low-lying regions Cyclonic rains are not so restricted, and the whole of a catchment area may be equally affected. Both types are generally sustained rather than intense. Intense rains in the British Isles are confined especially to England, more particularly central, southern, and eastern districts. Further, more intense rains have occurred in London than in any other region of similar size. They are typically thunderstorm rains of five hours' duration or less, long sustained falls being relatively rare there. Little information is available concerning the areas covered by intense falls of one hour or less In such cases it seems more likely that determinations could be obtained from the measurements of the discharge from small areas than from the records of rain-gauges.

THE attention of all systematists is invited to an appeal by Dr. Handlirsch (*Zool. Anz.*, **84**, p. 85; 1929) against the excessive splitting of systematic groups. As he rightly says, *Systematik* is and must remain the backbone of zoology, but it is an exacting study which is apt to absorb the whole energy of the systematist and to leave him little time, or perhaps inclination, to look around him at his fellow workers in zoology. It is often not realised that the excessive splitting of genera and species leads, as Handlirsch points out, to the obliteration of clues to phylogeny, and makes systematics more and more a study of its own, confined to a narrow professional class. He gives examples among insects of the splitting of genera, and others could be found in every group. One might say that one ceases to be able to see the wood for the trees As a matter of practical convenience, there is much to be said for the reduction of large genera to more manageable dimensions, but phylogeny is best expressed by retaining the original name and separating subgenera within it. The indefinite multiplication of names has introduced immense difficulties, not least of which is the application to them of nomenclatural rules. Handlirsch gives the example of the gorilla, orang, and chimpanzee. If these are separated as genera, there arises dispute as to which should retain the name *Simia*. Would it not be better if all were included in the old genus and distinguished when necessary as subgenera?

THE Report of the Industrial Fellowships of the Mellon Institute at Pittsburg University for 1928–29 relates to the eighteenth year of the working of the late Prof. Kennedy Duncan's foundation On Feb. 28, 1929, there were 62 Industrial Fellowships in operation, employing 145 research specialists and assistants, and about £160,000 was paid during 1928–29 by the fellowship donors in support of researches in the Institute. These statistics furnish eloquent evidence of the permanent success of the scheme A recent development has been the establishment of a pure research department, but judging from the investigations in progress in this department, many of which are medical and pharmacological, its name does not appear to be specially appropriate. The Report gives a schedule of the researches in operation during the year, with names of the fellows and their assistants. In addition to the Report, we acknowledge with thanks receipt of the pamphlet containing the list of books and bulletins, journal contributions, and patents by members of the Institute during the year 1928, copies of which are available for chemists, librarians, and teachers.

THE speed of transport by road has enormously increased during the last few years. A similar speeding up of electric express trains is now noticeable abroad. In the *Bulletin Oerlikon* for November, there is a description of four locomotives for the Paris-Lyons-Mediterranean Railway (P.L M.) which have just been completed. The most noticeable characteristic is that the maximum speed has now been increased to 80 7 miles per hour. The first of these locomotives was put into service at the end of June on the Mont Cenis line. These locomotives have the highest output of any yet built, being rated at 5400 horse power. The locomotives are no less than 78 feet long, have 18 wheels, and weigh 156 tons. They are capable of giving a

total tractive effort at the wheel rims of 40,000 pounds weight. The body of the locomotive is mounted on two bogies, each having three driving axles with corresponding twin motors There are thus twelve motors on a locomotive, and they can be grouped together in various ways so that a large number of economical running speeds can be obtained The closed-off driver's cabs at each end are connected together by two lateral gangways The sides and roof of the central compartment which contains the electrical apparatus can be detached for inspection when necessary. All the parts of the equipment which are not dangerous to handle are arranged along one of the gangways. All the high-tension switch gear is mounted along the other gangway and is unprotected as the entrance doors to it can only be opened when the current collectors are lowered and the main switch is open. The current is collected from the overhead line by two pantograph collectors and is returned to the third rail by means of four contact shoes on each side of the locomotive.

WITH the issue of the December number *Antiquity* completes its third year of publication This is an achievement upon which we offer the editor our hearty congratulations. Those who have any conception of the difficulties which beset the production and publication of a periodical which, while being popular in the best sense of the term, maintains a high scientific standard as well as a topical interest in its articles, will appreciate the courage which was required to start it and the indefatigable energy which has been necessary, not merely to maintain the initial aim, but even to go beyond it. In his introductory remarks to the December number, the editor points out that the very success of his publication constitutes its danger, as it has now come to be looked upon as established, though this is far from being the case. The contents for December strongly reinforce the editor's plea for further support from the public. They all deal in an authoritative, but not too technical, manner with matters which are more or less to the fore in archæology at the moment, and, above all, they are fully illustrated. The editor himself, in an article entitled "Woodbury", describes two photographs which "represent the culminating point of archæological air-photography"; Miss Caton-Thompson gives the first illustrated account of her excavations at Zimbabwe to be published in England; Dr. Oscar Reuther here makes the first report on the German excavations at Ctesiphon, which are opening up a new world; and Mr. G. Brunton describes the Badarian and Tasian civilisations—the most ancient civilisations of Egypt. These are some only of the contents of an excellent number, in which the news items are not the least entertaining and informative feature.

THE second meeting of Australian physicists, organised by members of the Institute of Physics, was held in Melbourne on Aug. 20–23; fifty delegates from all parts of the Commonwealth attended. The meeting was clouded by the sudden death, just before, of two of the most prominent personalities at the previous Conference at Canberra—Dr. Bieler, of the Imperial Geophysical Experimental Survey, and Dr. Duffield, Director of the Commonwealth Solar Observatory. There was a liberal and varied programme of papers. A discussion on seismic prospecting was opened by Prof A O. Rankine, whose short stay in Australia happily included the time arranged for the meeting. A preliminary account was given by Major Booth and Mr R L. Aston of the progress of experiments in New South Wales on the possibilities of the seismic method, which had been included in the scope of the geophysical survey at the suggestion of the Canberra meeting. Dr. N B. Lewis spoke on work with the gravity balance, and a preliminary description of a gravity balance of new design was given by Prof T. H Laby Prof. Kerr Grant, of Adelaide, described an improved type of Kater pendulum, in which the planes on which the pendulum swings are spaced by an end rod of Johannsen type. Astronomical contributions were made by the Melbourne and Mt Stromlo Observatories, and meteorological papers from the Carnegie Institution Magnetic Observatory at Watheroo (W.A ) were read. Papers on X-rays, ionic mobility, heat, were given by the University of Melbourne, Natural Philosophy Department, and some papers on various phases of wave mechanics by Mr. H. S. W. Massey. Mr. A. H. Turner, recently appointed physicist in charge of the Commonwealth Radium Laboratory, described arrangements made for the safe housing of ten grams of radium, and gave an account of accurate methods of measuring quantity Mr. Z. A. Merfield described some modifications carried out, with Sir Thomas Lyle, of the Grayson ruling machine.

AN article on electrification in Russia, by Dr Segal, which appears in the *Electrical Review* for Dec. 13, illustrates the ambitious programme of construction and extension which has been undertaken by the U.S.S.R. It is a continuation of the original programme initiated in 1920, which provided that by the year 1933 there would be 39 regional power stations working. This has now been increased to 48, having a total capacity of about three million kilowatts. It is contemplated that by 1934 the total capacity will exceed four and a half million kilowatts. The government considers that the progress of industry necessitates the acceleration of the construction of these stations. It has been decided to build a station on the Lukh river near peat bogs, so that the peat can be utilised as fuel. The power will be transmitted by high-tension lines to Nizhni-Novgorod, where a large motor-car factory, capable of producing 120,000 cars a year, is being constructed. The Chiatura manganese mines in Transcaucasia and sections of the Transcaucasian railway will be served by a large hydro-electric power station. In Leningrad three thermal stations are to be constructed in 1930. At present, one of the municipal stations is being extended. Leningrad will also be served by the huge Swir 180,000 kilowatt power station, the period of construction of which has been shortened. It is satisfactory to find that the increase in the electricity output is greater even than the increase in the number of stations under construction. The capital invested

in these undertakings during the current year is seventy million pounds.

AT the recent meeting of the British Association in South Africa, the general committee, learning with great regret that Dr. F. E. Smith would find it necessary to vacate the office of general secretary during the present winter, empowered the Council to appoint an acting general secretary during the period between the present month and the meeting of the Association at Bristol next year The Council has now appointed Prof. F. J. M. Stratton, professor of astrophysics in the University of Cambridge, to this office.

SPECIAL free facilities are being offered at the cinema in the Imperial Institute, South Kensington, S.W.7, where an interesting programme of films of historical and general interest has been arranged for the Christmas holidays. The programme includes "The Epic of Everest", the official film of the Everest Expedition (Dec. 22-28), "Outposts of Empire", Hong-Kong, Palestine, Gibraltar, Malta, Fiji (Dec. 29-Jan 1); "With Captain Scott in the Antarctic", the official kinematograph record made by Herbert Ponting of the story of Capt. Scott's immortal journey to the South Pole (Jan 2-Jan. 4); "Palaver", a film depicting the life of a district officer in Nigeria, in which the native parts are played by the Aura and Angas tribes (Jan. 5-Jan. 11), "The History of Electricity"; "The Making of a Lead Pencil"; and "Denizens of the Garden" (Jan 19-22). There are four sessions daily, at 10.15 A M, 11 35 A M, 2 15 P.M, and 3 35 P M, and two performances on Sundays at 2 45 P.M and 4 15 P M

BY courtesy of the president and council of the Linnean Society, a general meeting of British botanists will be held at the Society's rooms, Burlington House, Piccadilly, W 1, at 3 P M. on Jan. 10, when the chairman of the executive committee of the Fifth International Botanical Congress, to be held at Cambridge on Aug. 16-23 next, will report the progress made in organising the Congress. All interested in the matter are invited to attend

Two volumes from "The Thinkers' Library", published by Messrs Watts and Co. at 1*s* net each, have reached us One is "A Short History of the World", by H G Wells (pp x + 310), and the other is "On Liberty", by John Stuart Mill (pp. xiii + 144) No 'Thinker' should live in one little truth-tight compartment, studying the Arachnidæ, for example, until he behaves like a spider. To keep in perspective one needs a more general outlook, and works of reference are not so portable that one can take an encyclopædia to a dentist's waiting-room for temporary refreshment. So we have this little library, with Rodin's *Le Penseur* for its badge. Mr. Wells's "History" is a little disconcerting when we read that Solomon's Temple could be put inside a parish church. In any event, as a master of the art of synopsis, he has not been equalled by any writer in the English language.

## Our Astronomical Column.

**Naked-eye Sunspot.**—The prevalence of mist or fog at the time of a large sunspot usually results in the discovery of such a spot by a number of people previously unaware of its appearance, or of the frequency of large spots at times of maxima of the 11-year solar cycle. The large spot which crossed the disc on Dec. 10-22 is a case in point. The big circular spot (area 1000 millionths of the hemisphere), together with its cluster of followers, constitutes one of the largest groups of 1929, but it is only about two thirds the size of the largest groups of the present cycle. The meridian (long. 345°) passing through the centre of the group shows considerable disturbance; there is a small spot in lat. 20° N., a small group in lat. 13° N.; whilst a long stream (area about 900 millionths) lies in lat. 3° S The Greenwich magnetograph traces for Dec 16 are disturbed, the range in declination amounting to 35′ between $18^h$ and $20^h$. The table below follows from that which appeared in our issue of Dec. 7, p. 888.

| No | Date on Disc. | Central Meridian Passage. | Latitude. | Maximum Area. |
|---|---|---|---|---|
| 17 | Dec. 10-22 | Dec. 16 5 | 6° N. | 1500 |
| 18 | Dec. 10-22 | Dec. 16 7 | 3° S | 900 |

**Motions of the Planetary Nebulæ.**—Prof. C. D. Perrine discusses the nature and motion of the planetary nebulæ in *Astr. Nach.*, No 5670. He uses the photographs of the objects and their spectra obtained at the Lick Observatory by Prof. Campbell, assisted by Drs. Moore, Wright, and Curtis. He thinks that internal motion, both of a radial and a rotational character, is the key to many of the anomalies noted by them. Some of the nebulæ are concluded to be expanding and some contracting. The latter appear to have a harder and more definite outline The assumption that most of the shift of the spectral lines arises from internal motion gets rid of the puzzle presented by the high radial velocities of these objects, if the motion is internal the system as a whole may not have a high velocity with respect to the galactic system.

A graph is given of radial velocities grouped in relation to the angular diameter of the nebulæ. The velocities are found to vary inversely as the fourth root of the diameters. This law is taken as strong confirmation of the conclusion that the velocities are internal, for such a relation is then explicable on gravitational grounds, but no reason can be imagined for the velocities of the systems in space following such a law.

Prof. Perrine adopts as the most plausible hypothesis the view that the planetary nebulæ are the results of former outbursts of novæ, and that they have now attained an approximately stable condition.

**Reported New Comet.**—*Harvard Announcement Card* No 100 states that Mr. E. F. Carpenter found on Nov. 12 an image of a comet on a plate that he had exposed at Tucson, Arizona, Nov. 2·280 U.T., R.A. $2^h 25^m 2^s$, N. Decl 20° 8′ 57″, daily motion $+14^s$, −5′, magnitude, 16; length of tail, 30″. The direction of the motion was verified by the fact that the seeing was deteriorating during the exposure, and one end of the trail was fainter than the other. Dr. C. H. Smiley has deduced that the node is probably in the neighbourhood of 240° and the inclination small.

Mr. Carpenter has found another cometary image, also of magnitude 16, on a plate exposed by Mr P. C. Keenan on June 17·240 U.T, 1928, R A. $15^h 3^m 57^s$, N Decl 2° 2′, daily motion $5{\cdot}2^s$, 0·2′ either E.N. or W.S (*Publ. Astr. Soc. Pacific*, Oct 1929).

## Research Items.

**Social Organisation in Africa.**—Dr Thurnwald concludes his survey of African social systems in *Africa* for October The highest forms of social organisation in Africa are found in association with cattle and cultivation of the soil Many crafts are practised in the home for the benefit of the family Some callings are the monopoly of certain clans Clans may either be equal or socially graded, while there is also gradation within the clan In the larger units under a central authority the most diverse groups may exist side by side Generally, the tribes which are engaged directly in procuring the means of existence are the most primitive The higher organisation is based on the association of different tribes each specialising in an occupation. By this association, however, each tribe becomes more exclusive, as their livelihood depends more and more on the exchange of their products Among tribes such as the herdsmen of East Africa, a graded society is directed by sacred princes, society being stratified upon agricultural clans and hunters Among the herdsmen-farmers of South Africa, cattle-keeping is still the dominant factor In the Sudan and West Africa the organisation is that of a stratified peasant-pastoral with three grades of freemen, dependents, and slaves. The final form to be distinguished is that of the net-like state uniting various races under a king—a type of state internally associated with sacred rites such as that of Abyssinia and Kaffa, with an aristocracy derived from cattle and horse herdsmen, great families with slaves, the use of the plough and professional craftsmen of various kinds, who are also recruited from aboriginal rulers and immigrants

**Sumeria and Oceania**—Dr P. Rivet, following up his previous studies of the Oceanic group of languages in which he sought to show the influence the peoples of the Pacific had exercised on the Mediterranean and African worlds, now endeavours to trace a connexion between the Oceanic languages and Sumerian. He has published as No 24 of the *Collection Linguistique* of La Société de Linguistique de Paris, a vocabulary which gives his identifications in Sumerian, Melanesian, Polynesian, Australian, Tasmanian, Indonesian, Mon-Khmer, Munda, etc. The work is entirely lexicographical and grammatical affinities have not yet been explored The difficulty in the comparison of Sumerian and Oceanic vocabularies lies in the fact that the former are abstract, while the latter are concrete There are also certain phonetic changes. Sumerian, for example, does not show the tendency to nasalisation which appears in the Oceanic languages, and especially Australian. There are many examples of borrowing between Munda and Sumerian which are explained as due to commercial relations between Euphrates and Indus three thousand years before our era. A certain number of roots common to the Sumerian and the Oceanic group also appear in Indo-European and Semitic. This is also due to borrowing. The hypothesis which is put forward in explanation is that there was a single linguistic family of which the centre of dispersal was south or south-eastern Asia, and this spread by stages from Japan, as shown by Ainu affinities, to Tasmania, and from the Mediterranean and Africa to America. This takes us back beyond the age of bronze, which at present bounds our knowledge of the Indo-European tongues, to a much earlier period five thousand years before our era, and to, at least, the neolithic age. The vocabulary remained stable in remarkable degree throughout this long period.

**Increase of Elk in Sweden**—The European elk is strictly protected in Sweden, where the open season for shooting is restricted to four days The result has been a rapid increase in numbers, so that during the four days' shooting this autumn, some 3500 animals were killed, against 3700 last year (*Daily Science News Bull*, issued by Science Service, Washington, D C.) While sportsmen and naturalists rejoice at the change in status of the elk, farmers and foresters are less favourably disposed to protection Increasing numbers and competition for food have made the animals, formerly shy and elusive, extremely bold and occasionally ferocious In certain parts of Sweden they have damaged crops and young trees, and in places not only have they refused to budge from fields and gardens when called upon, but also have actually attacked farmers protecting their own crops.

**White-sided Dolphin in Scottish Waters.**—Formerly the general opinion was that this species was rare in British seas. Records of strandings collected by Sir Sidney Harmer, however, indicated almost annual occurrences, and the observations of Charles Oldham during the last few years suggest that it is present in schools of considerable size (*Scottish Naturalist*, 1929, p. 133) Its range in place here would appear to centre about the northern North Sea, and the records are confined to the spring and summer months, so that this may be another example of a temporary influx from the Atlantic Ocean. It ought to be added, however, that a young specimen, received at the Royal Scottish Museum, was caught in the latitude of Buchan Ness about mid-November of this year.

**Hay Rations for Dairy Cows.**—The importance of making the best use of hay in the feeding of dairy cows is the subject of an article by R. Bontflour in the *Journal of the Ministry of Agriculture*, vol. 36, p. 707. A system of rationing is strongly advocated, and the economy, which will be of particular importance to the farmer in view of the shortage of supplies during the present winter, is convincingly shown to be of real benefit to the cow and to increase her yield of milk The nutritional properties of hay vary considerably, a poor sample having only half the value of one of good quality. To obtain the best type of hay, early cutting is important, weathered hay if cut early being preferable to that got in under good conditions but cut late. Twenty pounds of hay a day is taken as the standard requirement for the maintenance of the average cow and for the sake of those whose supplies are insufficient to meet their needs, and who must use supplementary feeding stuffs, the equivalent ration of various substitutes are given. Of these sugar beet pulp and brewer's wet grains are specially recommended if purchase is necessary. However, it is pointed out that supplementary feeding may often be avoided if the hay is rationed and a pasture dressed with a hundredweight an acre of sulphate of ammonia in late January to secure an early bite. A cow allowed unlimited hay will consume more than she can digest, and a wastage of so much as one ton of hay per cow per winter may be accounted for in this way. It is equally important to ration hay fed in conjunction with concentrates or roots, for these may actually increase the cows' appetite for hay and decrease of milk yield will result from indigestion. As a conclusion a true story is related in which a prize for the higher milk yield was obtained by surreptitiously giving the opponent's cows an extra feed of hay.

**Marine Hydrozoa of the Faroes.**—Dr. P L Kramp gives a summary of all known hydroids from the Faroe plateau proper and the Faroe Bank in his "Marine Hydrozoa" (Zoology of the Faroes, Pedersens, Copenhagen, 1929). The recent investigations of 1925–27 have brought up considerable material which has, however, only added six species to the number previously known Fifty-nine species are now known from the Faroe plateau proper, inside the 200 m line. Three more species are added from the Faroe Bank. Some of the remarks on the distribution of the species are very interesting, for example, the capricious habit of *Clava squamata*, which occurs in some places abundantly and is absent from others which appear to afford exactly similar conditions, and *Dinamena pumila*, which only occurs when *Ascophyllum* is present, although it may grow also on certain species of *Fucus* Maps and tables are given showing the distribution of the more important species found on the Faroe plateau, almost all of which occur on the British, Norwegian, or southern and western Icelandic coasts, and many being common to the Mediterranean and South European coasts The evidence seems to show that the hydroid fauna of the Faroes is chiefly made up of species which have their main area of distribution in the more southerly regions, although there are arctic and boreal forms The author explains that this is due to transportation by free swimming medusæ or of hydroids fixed to floating objects, or that the polyps can live in deeper water, so that the sub marine ridges enable them to reach the Faroe plateau either from the north or from the south, and that in no case need we take into consideration the possibility of the survival from a time when the islands were more closely connected with other countries.

**Non-Nucleated Blastospheres of a Spider.**—Dr. E Warren (*Annals Natal Mus*, vol. 6, 1929) describes the incipient development of the eggs of three spiders (*Polystes natalius*) which were unable to produce eggs capable of full development In one spider (*D*) the eggs were certainly, and in another (*C*) probably, unfertilised, in the third spider (*G*) the condition was doubtful. About 80 per cent of the eggs of spiders *D* and *C* shrivelled and died on the second day after laying—due to lack of resistance to desiccation—but the surviving eggs resisted desiccation in the normal manner In the eggs of *D* no trace of formation of polar bodies could be detected, but a normal fertilisation membrane was formed in the eggs of all three spiders. The eggs of *D* underwent a certain progressive development; those of *C* exhibited at the time of laying a variable amount of development which progressed little further, the eggs of *G* appeared normal when laid and the central nucleus underwent mitosis, but there was complete inability to form a normal embryo In the eggs of *C* and *D* no trace of mitosis was found. The cytoplasm of all three lots of eggs exhibited a marked activity, numerous well-defined bodies being produced which looked like cells except that they had no distinguishable nuclei These bodies formed a perfect blastosphere—without a single nucleus being found in the epithelium—which flattened at one pole and produced by the proliferation of the non-nucleated masses a ventral plate. In the eggs of *G*, nerve ganglia were formed in a totally undifferentiated plasmodium.

**New Varieties of Hops.**—The twelfth report by Prof. E. S. Salmon, on the trials in 1928 of 102 new and commercial varieties of hops (*Journal of the Institute of Brewing*, 35, 523, 1929), is of special interest in that those plants, originally raised in or selected from the Experimental Hop Garden at Wye College, are now sufficiently established at East Malling Research Station for their distinctive characteristics to be ascertained. The most outstanding features are the high yields of 20 cwt. or more to the acre obtained from 23 of the hops, and the high preservative qualities of certain of the new varieties In particular, two of the latter gave values 1 52 and 1·21 per cent higher than that of the best hop obtainable in 1928, and there seems good grounds for believing that hops equal or superior in preservative value and flavour to the best American hops will be available for cultivation in England. In this connexion it is reassuring to learn that variety rather than soil or climate determines the brewing value of a hop. Investigations on the incidence of mosaic disease, which was high in 1928 though lower than in 1927, have shown that though many of the new varieties are themselves immune, they may act as 'carriers' of the virus, and so transmit the disease Though this transmission has at present been demonstrated only by grafting, it is clear that it may take place rapidly in hop gardens by other means, and a number of formerly puzzling cases are thereby explained A list of susceptible varieties is given. Observations of downy mildew confirmed the experience of previous years, namely, that a variety though severely attacked on its bines may be resistant on its cones, and conversely that severe attacks on the cones may occur while the bine remains healthy.

**Bibliography of Tides.**—A bibliography of tides for the years 1910–27 has been compiled by Prof. J. Proudman and published as *Bulletin* No 12 of Section d'Océanographie, Union Géodésique et Géophysique Internationale. The entries are chronologically arranged under ten headings. Only publications in a Latin or Teutonic language are included. Publications on the utilisation of tidal energy and ephemeral tide tables have been excluded.

**New Zealand Earthquake of June 17, 1929.**—Two preliminary reports on this interesting earthquake have recently been published, one by Messrs. H. T. Ferrar and L. I Grange, the other by Mr H. E. Fyfe (*N Z Jour. of Sci. and Tech.*, vol. 11, pp. 185-191, 192-197, 1929). The main centre of the earthquake appears to have been situated on the White Creek fault, which crosses the Buller River seven miles to the west of Murchison The re-levelling of the district by the Public Works Department shows that the country on the east side of the fault has been uplifted. At a distance of nine miles from it, there is no appreciable change of level, but towards the fault the change increases though with some oscillations At the fault, the east side has been raised 14 ft. 9 in., but, about 550 yards to the east of the fault, the uplift is 16 ft. 1 in. The course of the fault is marked by shattered ground and disturbed vegetation, trees lean over at all angles or are uprooted and split The block on the west side of the fault has not yet been re-levelled.

**Spectra of Xenon and Arsenic.**—The November number of the *Journal of Research*, published by the Bureau of Standards at Washington, contains papers by W. F. Meggers, T. L. de Bruin, and C J. Humphreys, on the arc spectra of xenon and of arsenic, both of which had been previously only incompletely described Xenon has been studied in special detail, and is likely to furnish lines which are even better suited for standards of wave-length than those of krypton The majority of the lines lying between 3000 A. and 10,000 A which have been measured—three hundred odd—have been fitted into a term scheme generally similar to those already known for the lighter inert gases, but there are certain differences consequent on the high atomic number of xenon which

will almost certainly be found to an even greater extent in the spectrum of radium emanation, which is now under investigation The analysis of the arsenic spectrum is less complete, and has been extended so far only to the infra-red and ultra-violet lines, new lines which have been found in the visible region not being included These papers have been made very readable by the inclusion of histories of the older work on the elements in question, and contain good large-scale reproductions of the spectra

Structural Stresses.—The Engineering Experimental Station of the University of Illinois has for some time been determining the stresses in structures of forms too complicated to admit of mathematical treatment by means of tests on models made of 'pottery plaster', which is plaster of Paris with an addition which delays its setting. *Bulletin* No 195 of the Station contains an account of the tests of beams of circular, rectangular, triangular, and H section bent into U shape, carried out by Profs. F. B. Seely and R. V James. In the first instance the legs of the U were forced together until the beam broke at the bend, then the two straight lengths were supported at the ends and loaded in the middle until the beam again broke. The results obtained show that the plaster model gives trustworthy information as to the maximum stress a structure will stand if five to ten tests are made and the mean taken. The H section beams broke at the abrupt change of section unless provided with a fillet of at least ½ inch radius.

Preparation of Telluric Acid.—Several methods of oxidising tellurium or its dioxide to telluric acid have been described A new one is given by Mathers and Bradbury in the November number of the *Journal of the American Chemical Society*. Tellurium dioxide is mixed with five equivalents of calcium hydroxide and heated at 975° for one hour exposed to air. Complete oxidation was very nearly attained The percentage of oxidation was smaller at lower temperatures or with less calcium hydroxide. The calcium tellurate was treated with an excess of concentrated nitric acid, whereby soluble calcium nitrate and insoluble telluric acid were formed This telluric acid, after filtration or decantation, was dissolved in water and crystallised until pure.

Enantiomorphism in Organic Compounds.—The October number of the *Journal of the Chemical Society* contains an important paper by John Read, I. G. M Campbell, and T. V. Barker, on the optically active diphenylhydroxyethylamines and isohydrobenzoins. The authors discovered that crystals of pure *d*- and *l*-isohydrobenzoin, when deposited from ethyl acetate, exhibit characteristic hemihedral facets; when chloroform is used as solvent, however, the distinctive facets are not developed Pure *dl*-isohydrobenzoin, when crystallised from ethyl acetate, separates as a conglomerate of enantiomorphously related crystals, composed of *d*- and *l*-isohydrobenzoin respectively, but the crystals deposited from chloroform are morphologically indistinguishable from one another so far as plane faces are concerned The latter crystals, however, have been shown by polarimetric observation to be also of two kinds, consisting again of the pure *d*- and *l*- forms; moreover, despite the absence of plane hemihedral facets, the two sorts of crystals can be segregated through the circumstance that either the right or the left side of each crystal displays a marked tendency to degenerate into curved boundaries. This diagnosis by means of curved surfaces is entirely novel, and is of great interest in connexion with the so-called 'Pasteur principle', namely, the establishment of molecular enantiomorphism from a study of crystal form. The authors point out that this principle cannot be accepted as generally true, for there is nothing in the undoubted enantiomorphism of structure of *d*- and *l*-isohydrobenzoin crystals which categorically demands plane-faced boundaries, still less facets indicating right- or left handedness. At the present time, the only question which can be raised is that of the frequency with which enantiomorphism of structure unfolds itself on the surface. Enantiomorphous hemihedrism among organic compounds is a good deal rarer than is commonly supposed, since in many cases it stands revealed only after repeated attempts at crystallisation, possibly with changes of solvent.

Hydraulic Pneumatic Engineering.—The *Journal of the Royal Society of Arts* for Nov 29, 1929, contains a paper by Mr J O Boving on new developments in hydraulic pneumatic engineering, in which particulars are given of many interesting applications of hydrautomats in which falling water is used for compressing or rarefying air and for raising water Simple forms of hydraulic air compressors have been built for centuries in the Vosges and Pyrenees for providing air for forges and the air lift pump is in common use Research work, however, has led to great improvements in such apparatus and many installations are now in use for irrigation and other purposes One compressor plant described is at Alston, Cumberland, where there is an available head of 180 feet The falling water is led to a steel separator tank about 400 feet below the top of the intake pipe in an old mine shaft from whence it again rises to a tail-race. The entrained air becomes compressed to about 90 lb. per sq. in and is used for drilling, etc A typical plant lifting water from a drainage canal is that at Bambanwala on the Upper Chenab Canal, Punjab, where a syphon rarefier works in conjunction with a continuous vacuum lifter which drains the town of Bambanwala Other installations described were those on the Rio Ebro in Spain, and at a tin mine in Nigeria. "There is", said Mr. Boving, "a wide field for applying the ideas to other uses, not yet fully explored."

Alternating Current Potentiometers.—Dr. C. V. Drysdale read a paper to the Institution of Electrical Engineers on Dec. 6, giving an historical account of the evolution of the a c. potentiometer and describing some of its many practical applications. He pointed out that no department of electrical testing involves such difficulties and such costly equipment as that of accurate a c. measurements Most of the instruments suitable for these measurements have a very limited range, owing to the fact that their deflections obey a square law. The ranges to be covered vary from a few millivolts to hundreds of thousands of volts and from milliamperes to thousands of amperes. As polyphase measurements have also to be made, special wattmeters have to be used for power and phase measurements. The cost of suitable apparatus to make all these measurements accurately runs to thousands of pounds and is beyond the means of all but the wealthiest factories. The direct current potentiometer first suggested in practical form by Sir Ambrose Fleming so far back as 1885 is the most universally used apparatus for d.c. measurements, and so many attempts were made to construct an a.c. instrument which could fulfil the same functions. One of the best of these instruments is the Drysdale a c. potentiometer. It is particularly useful for testing wattmeters and ordinary supply watt-hour meters. It can also be used for measuring the frequency of alternating currents and the magnetic fields which they produce. These instruments are much in demand in countries where facilities for obtaining special instruments are limited, but they are often in general use even in well-equipped laboratories.

## Modern Mining Explosives.

DR. WILLIAM CULLEN, who took the presidency of the Institution of Mining and Metallurgy on Oct 17 last, chose for his presidential address the subject of mining explosives, this being one with which the greater part of his life's work has been identified The address, therefore, constitutes an exceedingly valuable summary of the present position of the explosives industry, it is so rich in material that it is practically impossible to give an abstract of it which will do anything like justice to the large amount of matter it represents, there being practically no aspect of explosives with which Dr. Cullen has not dealt

Necessarily, Dr. Cullen devotes considerable attention to the use of nitro-glycerine and its products, which are used more extensively than any other mining explosive throughout the world to day He points out the dangers attending the handling of explosives in which the nitro-glycerine is frozen, and explains how of recent years this difficulty has been got over, there being two methods in use to-day In one the glycerine before nitration is polymerised, the nitrated polymerised glycerine acts like ordinary nitro-glycerine in all respects except that it does not freeze. The second method consists in replacing nitro-glycerine by dinitroglycol, which again behaves in all respects like nitro-glycerine except that it is not liable to freeze in winter Explosives in which one or other of these products replaces nitro glycerine to a sufficient extent to prevent freezing are generally spoken of as low freezing explosives and are used in all circumstances where ordinary nitro-glycerine explosives might be liable to freeze

Dr Cullen deals briefly with liquid oxygen explosives, but would scarcely appear to do them justice, they are used extensively in some parts of the Continent and are also used in open-cast work in Great Britain, as Dr. Cullen indicates; he states, however, that their use is attended with an economy of about 10 per cent, whereas some of the most recent authoritative statements on the subject show an economy of 30-50 per cent

As an all round explosive, Dr Cullen appears to favour explosives consisting essentially of nitrate of ammonia with a certain definite proportion of nitroglycerine He points out, however, that in coal mining special types of explosives must be employed because of the danger of initiating explosions of firedamp or coal dust It has long been known that gun powder, for example, is exceedingly dangerous in this respect both because it gives a fairly hot flame and also because the flame is one of long duration. The latter consideration is a very important one, and in connexion with this matter Dr. Cullen points out that the ordinary mercury fulminate detonator seems to be incapable of igniting firedamp, whereas the more modern tetral detonator with lead azide primer contained in an aluminium tube will always explode a mixture of firedamp and air

Dr Cullen is a keen advocate for the simplification of the explosives industry, for example, he points out that there are at the moment no less than 71 explosives on the British 'permitted' list, whereas probably a dozen would be sufficient, and that standardisation is here clearly indicated as a means of lowering the cost of such explosives without in any way diminishing their efficiency or safety

It may perhaps be of interest to add that Dr Cullen's address concludes with a reference to the interchange of technical information concerning explosives that is in existence between Great Britain and the United States of America, and in this connexion he refers to the recent award of the medal of the Institution of Mining Engineers to Mr George S Rice, Chief Mining Engineer of the U S Bureau of Mines. He points out that with European countries relations are cordial but are not so accurately defined as they are with the United States. It is surely not too much to hope that before very long the question of safety in mines, in which a proper understanding of mining explosives must always play a leading part, will be looked upon and treated as an international question, and that definite arrangements will be made with all countries in which the mining industry occupies a prominent position to pool all information tending to safety, thus avoiding needless duplication of effort and expenditure and directing research along the lines where it will produce the maximum degree of usefulness to mankind.

## Low Temperature Carbonisation in Power Station Practice.

THE Institution of Electrical Engineers arranged a discussion on Nov 21 on the low temperature carbonisation of fuel in combination with the generation of electricity. Prof. P Rosin dealt with German practice, S. McEwen with American, and E H Smythe and E. G Weekes with English practice. As all these speakers have had ample opportunity of familiarising themselves with the problem, their opinions deserve close attention

Prof. Rosin says that in Germany the original aim of carbonising bituminous coal for the sake of the tar and oil has met with disillusionment, and the principal object is now the production of a smokeless domestic fuel from fine coal slacks, while the utilisation of the gas receives increasing attention. Indeed, the only large low temperature plant working economically on coal is the K S.G. plant at Karnap—a unit of which is now installed at a London gasworks.

In power station practice the size of the coke product is unimportant, the available boiler plant being capable of consuming anything from dust to lumps. No value can therefore be assigned to the coke in excess of that of cheap low-grade boiler slacks—the cheapest grade of coal. It is therefore much more difficult to couple precarbonisation of coal with power production than to make economical domestic fuel, which commands the highest price in the market The capital costs must be very low and the yields of tar and gas high. In Germany, Rosin says these conditions cannot be realised, and "low temperature plants using pit coal . . offer no prospect of remunerative operation at present". With brown coal the position is different because the raw material, got without mining, is very cheap and the tar more valuable than the coal. Much of this tar is now being converted into motor spirit, 200,000 tons of which will be made this year. Nevertheless, the by-products are regarded as an unstable item of revenue, and the revenue from the sale of electricity should be regarded as the basis of any successful enterprise.

S. McEwen, speaking of American experience, voiced similar views on the economics of power station carbonisation. Owing to the low value of the coke for steam raising, it is essential to reduce the capital and labour costs to a minimum It was with this idea in view that the process of carbonising coal dust while falling through a vertical retort was developed by McEwen and Runge. The product

can be used directly as pulverised boiler fuel After various technical difficulties had been overcome, it came to be realised that the gas should be utilised for town gas supply in order to give the process a chance of economic success—the gas being the most valuable product This has necessitated embarking upon further modifications of the process so as to obtain a gas rich enough for distribution This last stage in the development of the process is now in process of development.

The two British workers described the 'Babcock' process, which has been the subject of experiment for ten years at the Dunstan station of the Newcastle Electric Supply Co In this case a Northumberland coal slack is subjected to heat by direct contact of a mixture of superheated steam and combustion products on its way to the grate of a stoker As this plant is now in its third year of operation, no doubt is felt as to its practicability, and designs have been prepared for a unit capable of dealing with 100 tons of coal per day, which will be commensurate with modern boiler practice. From 1 ton of coal costing 11*s.* it is said that by products valued at 8*s.* 11*d* are obtained, and considerable optimism is displayed as to the future of the combination.

In this respect, these opinions are scarcely in accord with those of Rosin and McEwen The former expresses the exact converse, while the latter regards the evaluation of the gas as a key to financial success It may be remembered that the existing producers at the moment find coal tar oils an embarrassing drug on the market. It will therefore be wise to suspend judgment as to the future of pre carbonisation of boiler fuel No appreciable reduction, if any, of the cost of generation, is to be anticipated. There would be a gain in the abolition of smoke by the power station and better conservation of the chemical values of the coal H. J H.

## Work of the Canadian School of Prehistory in France in 1929.

FOR four months, July to October inclusive, the Canadian School of Prehistory has been carrying on excavations in the classic hillside of Combe-Capelle, in the beautiful valley of the Couze—a tributary of the Dordogne, in which many *gisements* occur. It was there that some twenty years ago *Homo Aurignaciensis hauseri*, Klaatsch, was found. Mousterian, Aurignacian, and Solutrean materials, implements, engravings, etc, have also been found there, whilst a certain *terrasse* below the Plateau Ruffet appears to contain so many typical Acheulean hand-axes—*coups de poing*—that an Acheulean horizon seems indicated.

This is the fourth year of work by the Canadian School at Combe-Capelle, and one main *fouille* has yielded very interesting and practically unique types of tools of flint deserving special notice. Four collections of the very best found during this year's explorations were prepared for (1) The Musée national des Eyzies, Dordogne, headquarters of the School, (2) St. Germain-en-Laye, (3) Institut de Paléontologie Humaine, and (4) Le Musée Cartailhac, Université de Toulouse, Haute-Garonne

Besides these collections, which were labelled carefully as to precise geological strata from which they came, from Beds No. I., No. II., No III., No IV, occurring at Combe-Capelle, of which some twenty-five cases were shipped to Canada after inspection by the Beaux-Arts of Paris, other series were obtained from (1) Le Moustier (Upper Cave), and from the Émile Bompson property near the classic *abri* of that name. Four district beds, older than the oldest Mousterian known at Le Moustier Abri up to last year, were searched, and valuable and new information gathered of prehistoric value.

By request, the Canadian School was engaged in two other sites during 1929, namely, at Gavaudun, la Grotte du Moulin du Milieu, Lot-et-Garonne, where new facts were recorded of geological, palæontological, and archæological significance, (2) at Le Ruth, in the Vézère Valley, close to some old Mousterian *atelier*, which yielded some typical Mousterian implements besides teeth and bones of reindeer, lion, great stag, bison, horse, and claw of an eagle

The School also visited an Azilian Tardenoisian site near Sauveterre Lalémance (Lot), where a phase of these two periods seems to give some foundation to M Coulonges, digging there, in establishing a sauveterrian phase of the uppermost palæolithic of that region Geometrical pieces, microliths in large numbers, occur, associated with an abundant fauna, all of which will no doubt soon be described. The caves, rock shelters, and museums of the Dordogne or Périgord District were visited by the director and students of the (Canadian) School of Prehistory, every facility being afforded by M. Peyrony, administrator of the Beaux-Arts, to study the paintings, drawings, sculptures, engravings, and industries of the different ages represented in that remarkable locality Les Eyzies is the European headquarters of the School, and a few days were spent by some members of the School in the Ariège Caves, in the Grimaldi Caves of Italy, and in the Museums of Natural History in Toulouse and Marseilles, where excellent collections in prehistory are housed to advantage

The School's record of finds in France, Italy, England, and Holland have enabled it during 1929 to furnish the University of Toronto, that of Alberta (Edmonton), of Saskatchewan (Saskatoon), and of Manitoba (Winnipeg) with systematic series covering most of the periods in prehistory of the old and of the new Stone Age The headquarters of the School in Canada is in Ottawa, Laboratory of Geology and Palæontology, Elgin Annex, where the director of the School has his office. H. M. AMI.

## The Biblical Manna.[1]

THERE has always existed among scientific workers a wide divergence of opinion as to the true nature and origin of the manna, believed to have fallen from heaven to provide food for the Israelites in the Sinai desert during the Exodus from Egypt. Some authors considered the manna to be a desert lichen, *Lecanora esculenta* Nees, while others connected it with desert shrubs of the genus *Tamarix* and considered it to be either a physiological secretion of the plant, or its sap flowing from the wounds caused by insects. In order to solve this problem, the Hebrew University in Jerusalem organised in 1927 a small expedition to the Sinai Peninsula, and the leaders of that expedition, Dr. F. S. Bodenheimer and Dr. O. Theodor, have just published a very interesting account of their investigations.

The expedition visited some classical localities where manna was recorded. In the course of investigations,

[1] Ergebnisse der Sinai-Expedition 1927 der Hebräischen Universität, Jerusalem. Pp 143+24 tafeln (Leipzig. J C. Hinrichs'sche Buchhandlung, 1929.)

it was established beyond doubt that the appearance of manna is a phenomenon well known in other countries under the name of 'honey-dew', which is a sweet excretion of plant-lice (Aphidæ) and scale-insects (Coccidæ). Two scale insects mainly responsible for the production of manna were found, namely, *Trabutina mannipara*, Ehrenb., occurring in the lowlands, and *Najacoccus serpentinus* var *minor* Green, which replaces the former in the mountains. Two other Hemipterous insects, *Euscelis decoratus* Haupt and *Opsius jucundus* Leth, also produce manna, but to a lesser extent All these insects live on *Tamarix nilotica* var *mannifera* Ehrenb, no manna was observed on other species of *Tamarix*, a fact probably due to some physiological peculiarities of the former The authors observed the actual excretion by the insects of drops of clear sweet fluid, and proved by experiments that the fluid is ingested by the insects from the vessels of the phloem. When in an experiment a twig bearing the insects was placed in water, and the bark was cut below the insects, the production of manna continued in a normal manner, but it stopped as soon as the flow of carbohydrate solution from the leaves was interrupted by cutting off the bark above the insects. The dry desert climate of Sinai causes the syrup-like fluid excretion to crystallise, and the whitish grains thus produced, which cover the branches or fall to the ground underneath them, constitute the true manna of the Bible

A chemical analysis of the manna demonstrated the presence of cane sugar, glucose, fructose, and saccharose; pectines were also found, but there was no trace of proteins.

Detailed descriptions of the manna insects are given in the report, which includes very good photographs of various stages of the production of the manna Notes on the course of the expedition and on the fauna of the Peninsula of Sinai in general provide very interesting reading on that still practically unexplored country

## Fauna of the Batu Caves

THE Batu Caves, near Selangor, were discovered in 1879, and the general character of the caves and their fauna was made known in 1898 by H. N Ridley, and subsequent faunal records were made by Annandale and others. Mr. and Mrs. Cedric Dover have recently explored the caves, the total length of which is about 2500 feet, and their collection is the subject of a series of papers in the *Journal of the Federated Malay States Museums* (vol. 14, 1929).

The animals now reported upon include Mollusca, Crustacea, Nematoda (a new species of *Dorylaimus*), Arachnida, and seven orders of insects. Of the four molluscs, all gastropods, the genus *Opeas* was common throughout the cave, especially on damp boulders and on the walls, and both the species found (described as new) have eyes in which the pigment is small in amount or absent. Two isopod Crustacea are recorded—*Armadillo intermixtus* and *Philoscia dobakholi*—the latter, first described in 1924 from the Siju Cave in Assam, has "somewhat imperfect" eyes and a light colour

The late G. O. Sars has given a detailed description of a new species of *Parabathynella* taken from a small pool about 900 feet from the entrance to the cave. These examples have seven pairs of well-developed legs and a rudimentary eighth pair, as contrasted with only five pairs of legs in the European specimens of *P stygia* in which the three posterior trunk segments have no limbs—probably owing to their immature condition Prof. Sars did not accept Dr Calman's view that the Bathynellacea are Syncarida; he placed them in the division Anomostraca of the Malacostraca, and regarded them as "very primitive forms, apparently constituting the still living remains of an antediluvian fauna". Their primitive characters include the uniform segmentation of the body, the sharp definition of the first segment of the trunk, and their primitive limbs, and it is suggested that the Bathynellacea are the predecessors of the Amphipoda

The Arachnida include a Pedipalp, spiders of four genera, and a new species of the tick *Ornithodorus* Among the insects recorded are two genera of blattids, a strongly pigmented new species of *Gryllotalpa* (the first mole-cricket to be found in a cave), an earwig, a Myrmeleonid, and five species of Microlepidoptera, one of which, a *Tinea*, is common in the cave and its larvæ are abundant in the bat guano Of the ten species of Diptera collected, none shows any modifications for cave life Two Reduviid bugs are recorded and a dozen beetles—none markedly modified for a cavernicolous habit The discovery of many larvæ of beetles in the cave indicates that some at least of these beetles have found congenial conditions and are firmly established there.

## University and Educational Intelligence.

LONDON —The title of emeritus professor has been conferred on Dr. E. A. Gardner on his retirement from the Yates chair of archæology at University College, and on Dr. F. W. Oliver on his retirement from the Quain chair of botany at University College

The following doctorates have been conferred. D Sc. in chemistry on Mr. J. Bardhan (Imperial College—Royal College of Science), for a thesis entitled "I The Chemistry of Balbiano's Acid; II. The Action of Cyanoacetamide with $\beta$ diketones", Mr K. Krishnamurti (University College), for a thesis entitled "Investigations on the Scattering of Light in Colloidal Solutions and Gels"; Mr. F. G. Mann (Battersea Polytechnic), for a thesis entitled "The Complex Metallic Salts of the Aliphatic Polyamines". D.Sc in zoology on Mr William Rowan (University College), for a thesis entitled "Experiments in Migration, including an Investigation of the Sexual Rhythm and Histology of the Gonads in Birds". D.Sc in geography on Miss E G R. Taylor, for a thesis entitled "Studies in Tudor Geography, 1500–1583".

PORTSMOUTH Municipal College sends us a booklet issued on the occasion of the visit of H.R H Prince Arthur of Connaught on Dec 9 in connexion with an exhibition commemorating the twenty-first anniversary of the opening if the college. Erected, equipped, and maintained by the Portsmouth City Education Authority, it serves the higher educational needs of a wide area surrounding the city, including the Isle of Wight and parts of Hampshire and West Sussex, whence come twenty per cent of the technical college students. It comprises departments of science, arts, technology (mechanical, civil, electrical, marine, motor, and other branches of engineering, building trades and pharmacy), commerce and domestic science, and, in addition, a school of art and a training college, affiliated to the University of Reading, for women teachers It has thus, as pointed out in a foreword by the chairman of the governing body, the potential constituents of a university college The work includes, on the technical college side, full-time academic courses leading to degrees of the University of London in arts, pure science, engineering, etc, and, more recently, in pharmacy and a wide range of other courses both full time and part-time. The number of full-time students in this part of the College has increased from 66 to 507. The number of training college students has increased from 180 to 215.

COURSES in anthropology announced for the coming session in the University of Paris as usual cover a wide range, both in general subjects and in departmental studies For the diploma and certificate in ethnology, M Mauss lectures on descriptive ethnography, M. M Cohen on descriptive linguistics, M Rivet on physical anthropology, and L'Abbé Breuil on "Préhistoire exotique" There are also special courses on the ethnography and linguistics of Africa and further Asia, zoological and biological anthropology, quaternary geology and palæontology, and the psycho-physiology of man and the anthropoids Practical instruction in each course is given in museums Courses given at the constituent bodies of the University are as usual grouped under ethnography, sociology, human geography, prehistoric archæology, linguistics, and phonetics, physical anthropology and palæontology The course in linguistics is specially varied, and the lectures have obviously been arranged with the requirements of French colonial administration in view They include Annamese, Siamese, Cambodian, Amharic, Lao, Malay, Malagasy, the languages of Modern India, and Arabic Among the courses in ethnography may be noted one which will deal with the folklore of medieval western Europe and the formation of the Ossianic cycle from popular legend (M. Marx), and one by M Mauss on the belief in the efficacy of the spell in Australia and the relation of myth and rite in New Guinea. The civilisation of Central America and Peru will be dealt with by M Raynaud, and M. Cabaton covers the Malay Peninsula and Indo China.

THE Rhodes scholarships statement for 1928–29 shows that of 181 scholars in residence, namely, 96 from within the British Commonwealth and 85 from the United States of America, 58 were pursuing studies in law, 34 in natural science and medicine, 25 in English literature, 19 in philosophy, politics, and economics, 10 in Lit. Hum, 8 in mathematics, 7 in economics, and 10 in other schools It will be noticed that a large proportion (32 per cent) of the scholars elected to study law Moreover, this preference seems to have been most marked among the more brilliant, and especially so among the Americans. Seven out of twelve and seven out of thirteen who gained, respectively, first and second class honours, did so in the school of jurisprudence, the remainder being distributed as follows: natural science 5, modern history 3, philosophy, politics, and economics 2, and English 1. Of the eight American scholars who took firsts, six were in the school of jurisprudence. Most of the higher degrees and first and second class honours were won by scholars from the United States, as was only to be expected, having regard to the wealth of academic resources and the extent of the field of selection in that country as compared with those in the British Empire overseas. The statement includes interesting notes *de mortuis* and particulars of honours and appointments obtained by former scholars, and of new books published by scholars A former German Rhodes scholar is actively and prominently engaged in political life in Germany as a member of the Nationalist group in the Reichstag. A notable event of the year was a gathering in Oxford last July of old Rhodes scholars to celebrate the twenty-fifth anniversary of the inauguration of the scholarships. The celebrations lasted from July 4 until July 11. Old Rhodes scholars to the number of 190, 99 of whom were accompanied by their wives, were present. The central event was a dinner in Rhodes House on July 5 (the seventy-sixth anniversary of the birth of Cecil Rhodes), at which H R.H. the Prince of Wales was present, with Mr. Stanley Baldwin in the chair.

## Calendar of Patent Records.

**December 28, 1871**.—Antonio Meucci is an Italian claimant to the invention of the telephone. Meucci settled in the United States in 1851, and worked at his invention for many years, an attempt being made to start a 'Teletrophone Company', though this did not attract more than a few dollars of public support. A caveat for the invention was lodged in the United States Patent Office on Dec. 28, 1871, but was not taken up and lapsed at the end of the following year. Bell's patent was applied for in 1876

**December 30, 1775**.—John Arnold, the London watchmaker, invented the cylindrical helical form of balance-spring for chronometers and received a patent for the invention on Dec 30, 1775 A watch with the new spring was sent to Greenwich for an official trial in 1779, and successfully withstood all tests for a period of 13 months Its total error during this period was only 2½ minutes, whilst its daily rate never varied by more than 3 seconds.

**December 30, 1797**.—The self-acting hydraulic ram was first invented by Joseph Michel Montgolfier, the celebrated pioneer of ballooning, and patented in England in the name of Matthew Boulton on Dec. 30, 1797, the French patent not being granted to Montgolfier until six months later. The principle of the hydraulic ram had been first used for raising water by John Whitehurst of Derby, who sent a description of his apparatus to the Royal Society in 1770, detailing its application to a domestic water supply in which every time the tap was turned on and off in the kitchen a column of water was forced into a tank in the upper part of the house. The value of the apparatus for water-raising purposes was not recognised, however, until Montgolfier's invention.

**December 31, 1562**.—The first patent in the English records for a machine for the draining of mines was granted for twenty years to John Medley on Dec. 31, 1562. The grant recites that "in oure counties of Cornewall and Devon as in diverse other places of oure Realme of England there be diverse mynes as well of tynne leade and other mettall as of sea-cole whiche through the greate habundance of waters rysinge in the same are drowned and alltogether unoccupied", and that Medley has made "an engyne or instrument for the draynynge of waters not heretofore used in this oure Realme". It was the dependence of the mining industry on adequate water-raising devices that led to the invention of the steam engine.

**December 31, 1790**.—From the sixteenth century onwards patents for invention were granted intermittently by the French kings, but the first legislative enactment in France came into force in 1791, the Decree of the Assembly having been passed on Dec. 31, 1790. The first patent under the new law was granted in July 1791, and thirty-four were sealed before the end of the year

**December 31, 1842**.—In the early days of the semaphore railway signal, which was introduced in England about 1841, many suggestions were made for combining it with a lamp for night signalling. Rudolf Treutler, who obtained a Prussian patent for six years for his invention on Dec 31, 1842, proposed to attach to the semaphore arm a series of small mirrors all disposed in such a manner that they reflected the light from a lamp straight down the railway track for all positions of the arm, and thus illuminated the arm so that it was visible at considerable range. The arrangement was first used in 1844 on the Breslau-Freiburg railway and was adopted on a number of the Saxon lines, where it remained in use for many years.

## Societies and Academies.

### LONDON

**Geological Society, Dec 4.—Edward Greenly** Foliation in its relation to folding in the Mona Complex at Rhoscolyn (Anglesey). The major, minor, and minimum foldings (with their thrustings) have each given rise to a foliation and developed in chronological order The relations of major to minor folding furnish an explanation of the fact that the major cross-foliation, unlike a slaty cleavage, fails to traverse the pelitic beds The foliation of the plutonic intrusions, and the tremolite schists, are products of the major movements The principal metamorphism is independent of, and older than, the major and subsequent movements Its foliation is developed along innumerable thrusts, but these are at angles so acute to the bedding that, especially when thrown into rapid isoclines, they easily escape notice. This is the true explanation of 'monoplanic schists'. The early foliation is really the regional metamorphism. But the thrusting to which it is due, unlike those of the three later series, can be referred to no visible folding Accordingly, its disentanglement goes to confirm the hypothesis that recumbent folding exists, and is the dominant structure of the Mona Complex —**H P. Lewis** The Avonian succession in the south of the Isle of Man The rocks described occupy a 'key' position in relation to Carboniferous rocks of the Irish Sea area They lie within a basin, which is partly tectonic, between the Port St. Mary-Arbory fault on the north west, and the line of the Langness Ridge on the south east The lithological and palæontological divisions have been worked out

**Linnean Society, Dec 5.—Mrs. E S. Grubb** The biological station of Alto da Serra, São Paulo, Brazil This station consists of about 150 acres on the summit of the Serra do Mar, between the town of São Paulo and the sea Von Ihering, in 1909, when he was director of the São Paulo Museum, had his attention directed to the rich and interesting vegetation, and, obtaining a concession of land, began the organisation of the Biological Station, which, however, he was unable to carry on, and sold to the Government. In 1923 it again became attached to the Museum. A valuable feature of the area is that it comprises not only mountain forest, but also stretches of open marshland and grass vegetation, all alike subjected to extreme and continuous humidity The chief point about the Station is that no interference is allowed: nothing is taken out and nothing planted, and no clearance beyond cutting paths through the virgin growth to facilitate research and exploration It is the object of the Director both to retain the original vegetation so far as possible and to give what assistance he can in its investigation.

**Optical Society, Dec 12.—J. Guild** The insensitivity and personal equation errors of optical settings. The paper contains the results of observations on the insensitivity, that is, mean difference of the individual observations of a large series from the mean of the series, in the case of X type graticles set on vertical lines The influence of the following factors was investigated (1) Thickness of cross wires (best thickness subtends 60″-90″ at the eye), (2) angle between cross wires (best angle about 45°); (3) field brightness, (4) pupillary aperture (ordinary illuminations and apertures of 0·5 mm. and upwards have little effect on the insensitivity) Observations were also made of the magnitude of the 'personal equation' error in such settings

**Physical Society, Dec 13.—J H Awbery and Ezer Griffiths** Apparatus for determining the specific heat of a material in powder form A calorimeter suitable for heavy powdered materials, such as dry clay, is described It utilises the electrical method, and embodies a special form of stirrer suitable for these materials —**W. Edwards Deming** On the determination of the parameters in an empirical formula Some cautions regarding the use of the method of least squares were recalled The method recently mentioned by Awbery is compared with those of least squares and zero sum, from the practical point of view The method of zero sum appears to be the quickest and its results to be well in accord with common sense judgment —**N S. Alexander** The *J* phenomenon in X rays A series of experiments has been carried out with the view of repeating so far as possible the work of Barkla and others on the *J* phenomenon. The results obtained in no case provide any evidence for this phenomenon, and, considered in conjunction with the work of Dunbar, Worsnop, and Gaertner, they suggest that it has no real existence as an X ray absorption effect.

### DUBLIN

**Royal Dublin Society, Nov 26.—J H. J Poole**: The thermal instability of the earth's crust It has already been shown (*Phil. Mag*, March 1928) that the thermal history of the earth's crust depends on the fact that the melting point curve for the crustal materials is, almost certainly, steeper than their adiabatic curve in the fluid state The present paper is an attempt to solve the problem more completely, assuming that the crust may be treated as a crystalline solid with a definite melting point The stability of a liquid layer in such a crust is investigated. Taking the rate of transference of heat from the liquid to the overlying solid as proportional to their difference of temperature, two simultaneous differential equations are obtained, giving the rates of upward motion of the bottom and the top of the liquid layer, respectively These equations can be solved for the portion of the crust below the equilibrium position of the melting-point geotherm, where the loss of heat by conduction is sensibly zero, owing to the smallness of the temperature gradient When the layer moves upwards sufficiently to lose heat by conduction through the upper solid, the equations can be solved approximately if numerical values are inserted. This process has been carried out, and the history of the postulated system investigated —**T. Donnelly and J Reilly**. Low temperature carbonisation of peat Specimens of Irish peat were subjected to low temperature carbonisation under conditions which prevented any appreciable cracking of the tars, and preserved the wax and heavy oil A yield of 16 6 per cent of tar was obtained from an air-dried black peat, this tar contained 5 4 per cent phenol; unidentified higher acids; 4 4 per cent of 'resinals', and 0 9 per cent of 'resamines'. The peat also yielded 22·6 lb of acetic acid and 17 4 lb of ammonium sulphate per ton This is nearly twice the usual yield for these products. The yield of gas obtained is low (8·6 per cent by weight) and the quality poor, 42 per cent of carbon dioxide being present Wax and bitumen are present in the peat to the extent of 10 5 per cent.—**J. Reilly, T. V. Creedon, and P J Drumm** The nitration of substituted phenylbenzylamine derivatives.—**M Grimes**: A study of two new species of bacteria belonging to the genus *Chromobacterium*. In the course of the bacteriological examination of 36 samples of surface water, bacteria belonging to the genus *Chromo-*

*bacterium* were isolated in 17 cases. These cultures represent two new species named respectively, *Chromobacterium hibernicum* and *Chromobacterium cohaerens*

PARIS

Academy of Sciences, Nov 18 —E Mathias Contribution to the study of fulminating material The serpentine forms —A. Bigot The dome shaped ridges of the Cambrian of Carteret and the *Chlorellopsis* ridges —Charles Nicolle and Charles Anderson The Moroccan recurrent spirochætes of the *hispanicum* group are not separable into species The spirochæte of Mansouria is proved to be recurrent in man Only one group of spirochætes appears to be transmitted by ticks, *Sp hispanicum* —G. Nicoladzé The characteristic points of a curve belonging to a continuous system —J. Favard Researches on convex curves —Georges Valiron Some properties of algebroid functions —Harald Bohr A problem of M Borel.—Gaston Julia A development of holomorph functions —Jacques Chokhate The polynome of Tchebycheff of the best approximation —Radu Badesco · The distribution of singularities. The solution of a linear integral equation —Gr C. Moisil The theorem of infinite groups —W. S Fédoroff The growth of analytical functions and their differentials —Kourensky · The most general case of integrability of the equations of motion of a solid body in a liquid —A Lokchine · The bending of an anisotropic beam —A. Danjon The periodic displacement of the pole —Pauthenier and Mallard Contribution to the study of the cylindrical field in ionised air at the ordinary pressure The experimental control The results predicted by theory and found experimentally are compared graphically —J. Peltier The localisation of flaws in shafting —P Chevenard · The thermal treatment of ferro-nickels with two constituents —René Delaplace The disappearance of hydrogen in Geissler tubes If the tube is separated from the rest of the apparatus by a Dewar tube containing liquid air and this allowed to remain for 24 hours, in the tube thus freed from traces of water and mercury vapours hydrogen does not undergo irreversible contraction and no trace of carbon monoxide or of methane could be found. This negatives the suggestion that the dissociation of the internal wall of the glass tube may give rise to carbon compounds This is attributed by the author to the fact that when the tube is perfectly dry there is little or no production of atomic hydrogen. — Raymond Charonnat and Raymond Delaby: A new product derived from pyramidon Description of a product obtained by the reaction of pyramidon and perhydrol · empirically, its composition is a pyramidon dioxide —Georges Darzens: Hexahydrophenylethyl alcohol and some of its derivatives.—Marcel Faidutti Transpositions of ethylene oxides in the terpene series. Camphene and nopinene oxides, prepared by Prilejaieff's method, on distillation in the presence of silica or pumice powder, are really transposed into aldehydes Zinc chloride also causes the same change.—A Grebel Variations of the temperature of spontaneous inflammation of hydrocarbons in admixture with various substances, as a function of the proportion of these different substances in the mixture. The mixtures studied were petrol and absolute alcohol, and ternary mixtures of petrol, absolute alcohol, and benzene The effect of small additions of acetone and of aniline was also studied.—E. Raguin. Has the vermicular bundle of Zermatt its homologue in the geological structure of the Haute-Marienne ?—J Thoulet. Submarine mineral springs. —Pierre Dangeard: Some new algæ containing iodine. 120 species of marine algæ have been examined by a microchemical method for iodine.—H. Labbe, Heim de Balsac, and R Lerat The theosterols of cocoa Estimations of the sterols in cocoa butter, and in the beans, germs, and husk The fat extracted from the husks was very rich in sterols, about twenty times the amounts found in the butter extracted from the whole bean —Emile F Terroine. The preparation of artificial milks for raising cattle —André Mayer and Georges Nichita. The water emitted by vaporisation and its relations with the respiratory exchanges in homeotherms The ratio $H_2O/CO_2$ —Loeper, André Lemaire, and Jean Patel A method of recording graphically the pressure of the cephalo-rachidian fluid —Fernand Mercier and Jean Régnier Lævorotatory cocaine and dextrorotatory pseudococaine the comparative toxicity and different destruction by the animal organism —Rene Hazard. Researches on the antagonism of the base tropine (tropanol) and of pilocarpine on the heart —Marcel Mascré and Maurice Herbain The influence of formaldehyde on the precipitation of the nitrogenous matters of urine by trichloracetic acid —E Brumpt. The evolutive cycle of *Schistosoma bovis* (*Bilharzia crassa*), a spontaneous infection of *Bullinus contortus* in Corsica —M. Belin. The presence of antibodies in the pus of the fixation abcess

VIENNA.

Academy of Sciences, Nov 7 —W J. Muller and L Holleck The theory of passivity phenomena (7). The anodic behaviour of copper in sulphuric acid electrolytes The behaviour of the copper was tested under varying conditions of concentration of acid, of saturation of copper sulphate and of temperature. The equation previously found connecting initial current density and time of passivation was confirmed. The first formed layer is of copper sulphate pentahydrate. Afterwards this is transformed, as shown by polarised light —W. J. Muller and L. Holleck. The theory of passivity phenomena (8) The anodic behaviour of zinc in sulphuric acid electrolytes Zinc shows surface passivity, at first due to zinc sulphate heptahydrate. A secondary transformation sets in the more rapidly the weaker the sulphuric acid —W J. Muller and K. Konopicky: The theory of passivity phenomena (9) The passivity of lead in sulphuric acid and the contribution to the theory of the formation of the lead anode Results were obtained by measuring the current-time curves of lead in accumulator acid at constant potential. The passivation time is very short corresponding to the difficultly soluble lead sulphate Current-time curves were measured with the oscillograph. An increase of solubility is explained by the hydrolysis of quadrivalent lead going into solution —W. J. Muller and K. Konopicky (10) · The time law of self passivation.—W. J. Muller and W Manchu (11): The anodic behaviour and passivity of iron in sodium sulphate solutions. An oxidised film forms on iron both in air and in air-saturated solutions, and very rapidly This introduces a difficulty in the determination of the passivation time for iron.—L. Moser and F. Siegmann · The determination of indium and its separation from the monoxides and sesquioxides. Indium has little analytical resemblance to gallium. $In(OH)_3$ is practically insoluble and may be precipitated with ammonia. $In_2S_3$ is completely precipitated by hydrogen sulphide in acid solution and allows of a quantitative separation of indium from iron and aluminium. Zinc, nickel, and chromium are separated from indium by potassium cyanate, cobalt by potassium cyanide.—N. Froschl, J. Zellner, and H. Zak: Synthetic experiments in the sugar group (1). Some derivatives of fructose and lactose. With heptaacetyl-bromlactose there were obtained good crystallising acetyl-lactosides of menthol, glycol, etc.—G. Machek: The linear pentacene series (18). Two

isomeric dibromo derivatives of the linear pentacene-diquinone-5, 7, 12, 14.—F. Lieben and G Ehrlich The decomposition of glucose and fructose by *Bacillus coli*. Fructose is more rapidly attacked than glucose

Nov. 14.—M Beier Results of a zoological expedition to the Ionian Islands and the Peloponnesus (4) Myriopoda by K. Attems (5) Reptilia, Amphibia, Orthoptera, Embidaria, and Scorpiones by F Werner —J Mayer · The absolutely smallest discriminants of the biquadratic number-body —G Nobeling The theory of regular curves The theory of universal assemblages Remarks on a theorem by O. Schreier

Nov 21 —W Figdor. The positive geotropism of the axial bulbs in *Gloriosa superba* —H Pettersson The disappearance of radon in quartz capillary tubes during electrodeless discharge. To be compared with the disappearance of xenon in discharge tubes —S Schneidt The electro chemical behaviour of polonium in solutions of various hydrogen ion concentration Polonium must be in the colloidal form in dilute solutions.—M Hoschtalek · The conductivity on old and new rock-salt surfaces in damp air The conductivity is first noticeable when the vapour pressure of the air is above 4 4 mm —K W F. Kohlrausch · The calculation of chemical bonding forces from the frequencies of the Raman lines —A Steuer The species of the Copepod genus *Acartia* in the Mediterranean province

## Official Publications Received.

BRITISH

The North of Scotland College of Agriculture Report on the Work of the North of Scotland College for the Year 1928-29 Pp 30 (Aberdeen)

Records of the Indian Museum Vol 31 Part 2, July Pp 81 150+ plates 6 ? 12 rupees, 8s Vol 31, Part 3, September Pp 161 257+ plates 7 11 2 12 rupees, 5s Vol 30, Appendix List of Literature referring to Indian Zoology (excluding Insecta) received in Calcutta during the Year 1928 Pp xxvi 7 annas, 9d (Calcutta)

Memoirs of the Indian Museum Vol 9, No 3 A Revision of the Fissilabioidae (Cordulegasteridae, Petaliidae and Petaluridae) Part 1 Cordulegasteridae By Lieut Col F C Fraser Pp 69 167+plates 9 12 (Calcutta) 4 6 rupees, 7s 6d

FOREIGN

Report of the Aeronautical Research Institute, Tokyo Imperial University No 49 A New Index to Control Cable Endurance By Taitiro Ogawa and Sigetake Suzuki Pp 243 258 0 22 yen No 50 Air Flow through Suction Valve of Conical Seat Part 1 Experimental Research By Keikiti Tanaka Pp 259 300+plates 13 16 1 17 yen (Tokyo Koseikai Publishing House)

Regenwaarnemingen in Nederlandsch Indie Vijftigste Jahrgang, 1928 Pp ii+138 (Weltevreden Landsdrukkerij)

Proceedings of the Imperial Academy Vol 5, No 8, October Pp xiii xx+307 402 (Tokyo)

## Diary of Societies.

*SATURDAY*, DECEMBER 28.

ROYAL INSTITUTION OF GREAT BRITAIN (at Institution of Electrical Engineers), at 3 —S R K Glanville How Things were done in Ancient Egypt (Christmas Lectures) (1) The Elementary Use of Nature

*MONDAY*, DECEMBER 30.

ROYAL SOCIETY OF ARTS, at 3 —Capt C W R Knight The Golden Eagle (Dr Mann Juvenile Lectures) (1)

*TUESDAY*, DECEMBER 31

ROYAL INSTITUTION OF GREAT BRITAIN (at Institution of Electrical Engineers), at 3 —S R K Glanville How Things were done in Ancient Egypt (Christmas Lectures) (2). Making a Home

*WEDNESDAY*, JANUARY 1

ROYAL SOCIETY OF ARTS, at 3 —Capt C W R Knight Wild Life in the Treetops (Dr Mann Juvenile Lectures) (2)
CHILD STUDY SOCIETY (at University College), at 5 30
ROYAL MICROSCOPICAL SOCIETY (Biological Section)

*THURSDAY*, JANUARY 2.

ROYAL INSTITUTION OF GREAT BRITAIN (at Institution of Electrical Engineers), at 3 —S R K Glanville How Things were done in Ancient Egypt (Christmas Lectures) (3) Building in Stone
PHYSICAL SOCIETY (at Imperial College of Science and Technology), at 5 —

*FRIDAY*, JANUARY 3.

INSTITUTION OF MECHANICAL ENGINEERS, at 6 —Eng. Vice-Admiral R W Skelton Progress in Marine Engineering (Thomas Lowe Gray Lecture)
INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7 —J G Wellings and C G Mayo Instrument Transformers
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Informal Meeting), at 7

*SATURDAY*, JANUARY 4

ROYAL INSTITUTION OF GREAT BRITAIN (at Institution of Electrical Engineers), at 3 —S R K Glanville How Things were done in Ancient Egypt (Christmas Lectures) (4) Boats and Furniture

### CONFERENCES.

JANUARY 1 TO 3

EDUCATIONAL ASSOCIATIONS (at University College)

*Wednesday, Jan* 1, at 3 —Prof Winifred Cullis The Line of Investigation (Presidential Address)

EUGENICS SOCIETY

*Wednesday, Jan* 1, at 5 —Prof E W MacBride The Teaching of Biology in General Education

CHILD STUDY SOCIETY

*Wednesday, Jan* 1, at 5 30 —Dr H Crichton Miller The Study of the Child

SCHOOL NATURE STUDY UNION

*Thursday, Jan* 2, at 3 —Dr C T Green Our Beautiful Wild Flowers

NATIONAL COUNCIL FOR MENTAL HYGIENE

*Tuesday, Jan* 7, at 3 —Discussion Preventable Mental and Physical Strains of School Life

JANUARY 1 TO 4

SCIENCE MASTERS' ASSOCIATION (at Imperial College of Science)

*Wednesday, Jan* 1, at 8 15 —Prof J C Philip Presidential Address

*Thursday, Jan* 2, at 10 30 A M —A F Walden Lecture on Liquids, with Discussion on Broadcasting

At 5 —S R Humby Lecture Experiments in Sound with an Electrically Controlled Source

At 8 15 —Prof W A Bone, assisted by R P Fraser The Photographic Investigation of Flame Movements in Explosions (Lecture)

*Friday, Jan* 3, at 9 30 A M —W Corbridge Lecture Demonstration on Some Home Made Physical Apparatus

At 10 45 A M —Dr J C Munro Industrial Biology (Lecture)

At 12 —Prof Truscott and others Discussion on Openings for College Trained Men in the Mineral Industry

At 5 15 —Discussion with the Physical Society on Examinations in Practical Physics

At 8 15 —Discussion on School Certificate Biology

*Saturday, Jan* 4 —Visits to the National Physical Laboratory and the Government Laboratory

JANUARY 2 TO 6

GEOGRAPHICAL ASSOCIATION (at London School of Economics)

*Thursday, Jan* 2, at 11 30 A M —Sir Henry G Lyons Presidential Address

At 5 —Discussions —Village Survey Making Opened by Miss J K Jones —The Inter Relation of History and Geography in Central Schools Opened by Miss D Sarjeant —Land Utilisation Map of Northampton Opened by E E Field

At 6 15 —H E Raynes Mortality of Europeans in Equatorial Africa—A Study of the Effect of Improved Conditions and Mode of Life (Lantern Lecture)

*Friday, Jan* 3, at 10 A M —Discussions —The Physical Basis of Geography in Independent Schools Opened by B B Dickinson —Geography and the Training of Teachers Opened by T Herdman

At 11 30 A M —Col H L Crosthwait Air Survey (Lantern Lecture)

At 2 30 —The Geography I was Taught, by Members of the Association

*Saturday, Jan* 4, at 10 30 A M —Sir E J Russell Agricultural Developments in South Africa (Lantern Lecture)

At 11 45 A M —Dr Vaughan Cornish National Parks

JANUARY 6 AND 7

MATHEMATICAL ASSOCIATION (Annual Meeting) (at London Day Training College)

*Monday, Jan* 6, at 4 —B L Gimson and others Discussion on Arithmetic of Citizenship

At 5 30 —Prof S Chapman The Use of Spherical Harmonic Functions in Mathematical Physics

*Tuesday, Jan* 7, at 10 A M —G W Spriggs and others Discussion on Problems of Individual Education, with Special Reference to Work in Mathematics

At 11 45 A M —Prof W M Roberts Gunnery and some of its Mathematical Problems (Lecture)

At 2 30 —Dr. W F Sheppard Mathematics for Study of Frequency Statistics

At 3 45 —Miss Hilda P Hudson and others · Discussion on The Mathematician in Ordinary Intercourse

### EXHIBITION.

JANUARY 7, 8, AND 9

ANNUAL EXHIBITION OF THE PHYSICAL SOCIETY AND THE OPTICAL SOCIETY (at Imperial College of Science), from 3 to 6, and from 7 to 10.

*Jan* 7, at 8 —Lord Rayleigh · Iridescent Colours in Nature from the Standpoint of Physical Optics (Lecture).

*Jan* 8 —S G. Brown Gyro Compasses for Gun Fire Control (Lecture)

*Jan* 9 —Sir Ambrose Fleming Television, Present and Future (Lecture).